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POPULAR MECHANICS

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Bright Summer IDEAS

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America's Supersecret Spy Plane That Outflies the U-2

**HOW
TO:**

Choose and Use Nails

Select an Electric Motor

Pick the Right Propeller

Buy Your First Motorcycle

Knurl on a Metal Lathe

Troubleshoot Your Outboard

Make Wide-Panorama Photos

Check Your Car's Compression

CARS: What Owners Think of Javelin and Road Runner ☐ Auto Clinic ☐
Driving Toyota's New 1100-cc Corolla ☐ Dan Gurney's Column on Racing
and Driving ☐ Bill Kilpatrick Tests the Exciting Go-Anywhere Amphicat



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LETTERS TO THE EDITOR

Down with super-dupers

That item about tire grading in the April *Detroit Listening Post* (page 22) hits a responsive chord with me. I'd like to see about four tire grades from A (best) to D (cheapest) and do away with the seven or eight super-duper designations now in use. I cannot for the life of me understand tire nomenclature—and I am a buyer!
OKLAHOMA CITY, OKLA. LESTER LLOYD

Wrong author

Somehow I was given credit for being author of *Build This Cartop Pontoon Boat* (page 150, Feb. PM). Although I helped produce some of the drawings, the boat was designed and built by Davis Pratt, co-chairman of the Department of Design, Southern Illinois University.
SKOKIE, ILL. DAVID M. SWARTWOUT

Or count on your fingers

A Computer in the Basement? (page 77, April PM) is a great story. It might be a good idea to publish the plans for the computer.
BOXFORD, MASS. DANA GOULD

That computer would take about all the rest of our pages for the whole year. How about an abacus?

If you drive, don't breathe

In regard to auto safety: Why not have a built-in breath sniffer in a car? If your breath is too strong, the auto will not start.
INDEPENDENCE, KANS. WALTER UPTON

It could be awfully embarrassing if you hadn't been drinking.

The case for fog lights

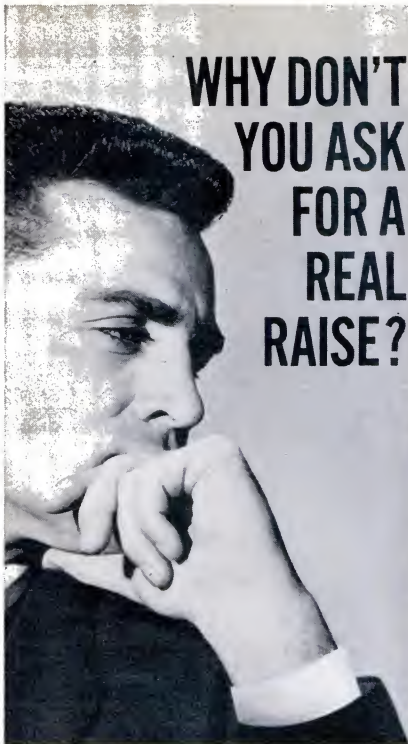
In your February *Drivin' With Dan* (page 40) you printed a question about the value of yellow fog lights.

There is scientific reasoning behind the use of amber lights in fog.

Fog is a suspension of a liquid in a gas, a colloid, or more accurately, an aerosol. In a colloid the suspended particles scatter light.

Visible light has a wavelength of 4000 to 7200 angstroms. Colloid particles may be several thousand angstroms in diameter;

(Please turn to page 8)



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LETTERS

(Continued from page 6)

it is easily shown that if we reduce the particle size in a colloid we will not have any reflection of light. Now, what if we increase the wavelength of the incident light? The same thing!

Yellow light has a longer wavelength than white light. Yellow fog lights will not produce the haze that regular headlights would.

CORVALLIS, ORE.

DALE RONSIN

Ammunition for owner

High in Style, Low on Mileage (page 98, March PM) describes the Chevy Chevelle exactly. It's what I've been trying to tell my dealer, who holds to the view that General Motors can do no wrong or build no gluttons. Your article, of course, did not please him, but provided me with good ammunition in our negotiations. I only wish your article had come out before I bought my Chevelle.

WINDSOR, N.S.

H. G. SEARLE

No broken wrist now

In your January Owners Report on the Rambler American (page 117), you show a picture of a door handle that you describe as a "wrist breaker." Well, it is—but I solved the problem on my Rambler. I simply removed the handle and put it on facing up. It works very well.

CROYDON, PA.

WILLIAM TULIBACK

Great idea! However, one word of caution to Rambler owners. The tip applies to '67 Ramblers only; the '68s have entirely different door handles.

Wants mightier Mini

In your comparison of the new Honda N600 with an Austin Mini (*Handy Little Honda*, page 88, March PM), you gave the impression that the Mini is not a very good car. I realize that you used an 848-cc model but I feel that if you road-tested an Austin Mini 1275S, you would see how good the Mini is.

INDIO, CALIF.

TIM GAUL

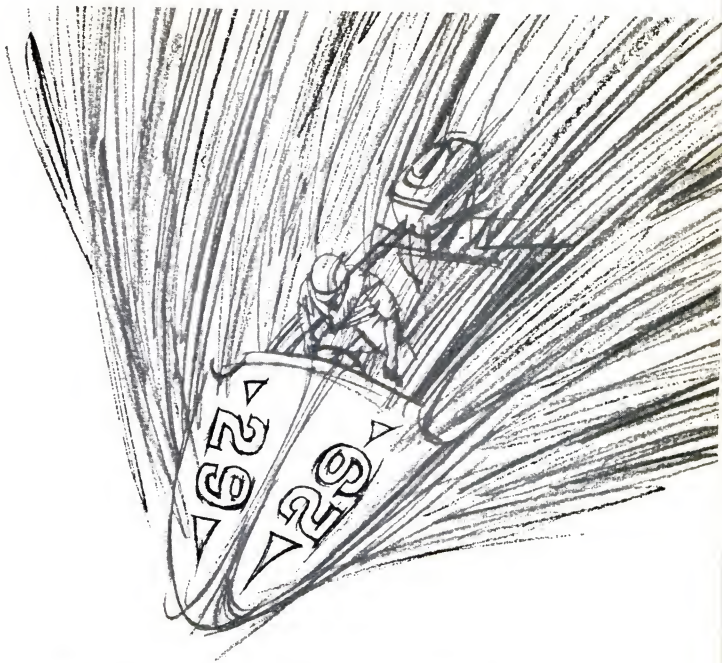
But that 848-cc Mini engine is already bigger than the 599-cc powerplant in the Honda 600!

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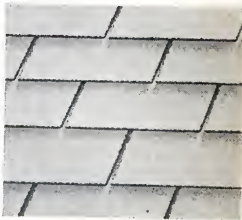
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Drivin' with Dan

Can a car owner trust the manufacturer's recommended service schedules? What's the minimum age for racing drivers? What do you think of turbine race cars? Dan Gurney answers these and other provocative questions



DAN WRINGS OUT his sleek '68 Championship Eagle in test runs at Riverside Raceway. He reported the car as exceeding his hopes for new chassis and engine

Q. *I don't like the idea of turbines racing anywhere (much less Indianapolis), but it seems the four-wheel drive is a pretty good one. What do you think?*—Jim Vincent, Bloomington, Ind.

A. We're eye-to-eye (or is it ear-to-ear?) on turbines. Besides the difficulty of properly handicapping turbines as we do piston engines, and the question of how relative they are to motoring in general, I feel their lack of sound removes one of the most exciting aspects of the sport. And yes, four-wheel drive is a good idea for all types of racing cars. So far, the biggest drawback has been development of a reliable system for racing and being able to spare the power to operate it. Progress is being made, though, and we'll probably see widespread use of four-wheel drive in the near future.

Q. *I just bought a go-kart. Where can I practice?*—Bill Scheeler Jr., Westbury, N.Y.

A. Finding a place to practice is one of the toughest problems an aspiring driver has to solve, but you're more likely to find suitable spots with a go-kart than with a larger

machine. With permission, a large parking lot will do nicely. Just make sure it's empty and be very careful of the proximity of walls, telephone poles, and so on. You'd be surprised how far you can go sometimes when you're out of control.

Q. *I'm a girl, 15 years old, and I like to help my father and brother work on their cars. Some people say I should leave this work to the men. Do you agree with them?*—Gail Beebe, Fort Wayne, Ind.

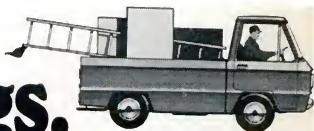
A. Well, it does seem a bit like a man knitting, but if you enjoy doing it, more power to you.

Q. *Do you think a car owner can trust a manufacturer's recommended service schedules, or should a passenger car be serviced more often? I suspect they may be trying to relieve dealers of nonpaying customers.*—Jim Redmond, Fresno, Calif.

A. I'd be inclined to go along with a manufacturer's recommendations, but would stay

(Please turn to page 12)

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DRIVIN' WITH DAN

(Continued from page 10)

on the alert for any unusual problems. Service is a big part of selling cars and I doubt any manufacturer can afford to risk misleading customers just to ease the servicing load.

Q. Why doesn't Mercury advertise your Riverside 500 stock car win in a Cyclone?—Billy Smithwick, Rock Hill, S.C.

A. Because I was aboard a Ford Torino. The Cyclone couldn't be made ready in time.

Q. Is it true various international sanctioning bodies are trying to eliminate Le Mans-type starts? I think they're great!—Ben Huntley, Chicago.

A. Seems so, but I understand they are still being used in enduro-type races both here and abroad. A Le Mans start is interesting to watch, but it can make for some hairy moments for the drivers. Also, where a large number of competitors are concerned, it's difficult to prevent wholesale cheating on the countdown. Personally, I always got a kick out of peeling off a couple of false starts, just to keep the officials loose.

Q. Do Grand Prix cars use the same kind of fuel as Indy cars?—R. J. Rollins, New Orleans.

A. No. Formula 1, or Grand Prix, cars must run on pump gas. Methanol is the big fuel at Indy, although the use of nitrates is increasing.

Q. I'm confused about the Italian Grand Prix. Some diagrams show a course 6.2 miles long, with some parts of the track passing over other parts, while other layouts show a 3.6-mile course with no passovers. Can you explain this?—Michael Carver, Brigham City, Utah.

A. The Italian GP has several options. The race hasn't been held on the full circuit since 1961, when it included the banking that passes over the road course. The concrete banking became so rough through the years that it was terribly hard on suspensions. So rather than build special cars and tires for only one race, the banking was abandoned.

Q. What do you think about a Buick 445-cu.-in. engine for racing?—David Watson, Sullivan, Ind.

A. While it's probably a darn good engine,

it doesn't fit any particular racing formula in which I'm involved, so I really don't know much about it. Just about any of the current crop of U.S. V8s can be made to go very well, but unless you're a real lone wolf, I'd stick to the well-known racing plants.

Q. Do you let God have a part in your driving skill?—Reggie Clark, Clarksville, Ark.

A. Certainly, but I also try to do the best job I can and avoid leaving it all up to God.

Q. Have you ever given any thought to driving a sprint car?—Mike Turner, Gardena, Calif.

A. Yes, I have. I've watched a lot of sprint car racing and I enjoy it as a spectator. But the prestige and purses are greater in other types of racing, and I've never been able to justify my driving a sprint car.

Q. How old does a fellow have to be to start racing?—Malcolm Lovelace, Springfield, Ohio.

A. You can start at any age as long as you are not on public roads. At Indianapolis, the minimum age is 21; at most other tracks, 18. Forgery, by the way, is against the law.

Q. In racing, what does it mean when they say a car is "out of shape"?—George Bender, Toledo.

A. Strictly speaking, I suppose it means the car is out of control. I say "suppose" because there are times when a car is off-line, or in an attitude other than what is the theoretical ideal. Such a car, while not necessarily out of control, is nevertheless deemed "out of shape." If, on the other hand, you read or hear that a driver "lost it," you'll know he did in fact lose control.

Q. How come you haven't written a book about your racing career?—John Smock, Buffalo.

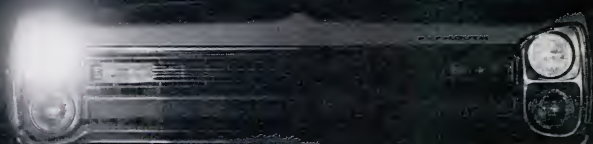
A. One thing at a time, John. Right now I'm up to here in my racing career and I just don't have time. I hope to someday.

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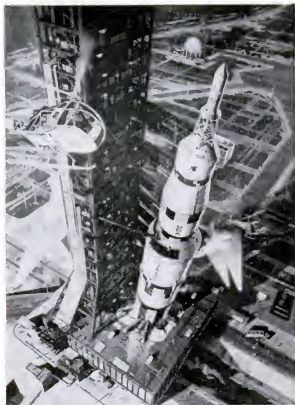
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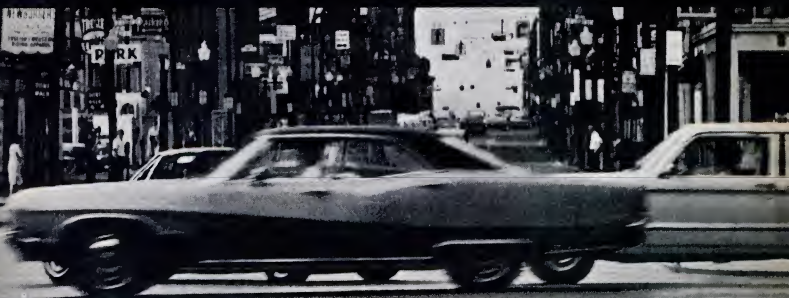
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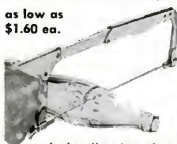
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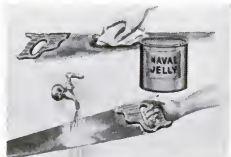
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Science Worldwide

BY JOHN F. PEARSON

Irradiation may be the key to successful tooth transplants. So says a UCLA dentistry professor who reports that one of his patients has a healthy molar that was implanted seven months ago and shows no signs of biological rejection, a problem with tooth transplants as well as internal organs. Cobalt irradiation sterilizes the newly extracted tooth and apparently alters the protein material that normally triggers the rejection process. If successful, the new method would make tooth banks possible.

First land vertebrate fossil ever found in Antarctica—a 2½-inch piece of jawbone—may provide a clue to the origin of Southern Hemisphere continents. Discovered by Ohio State University geologists, the bone is from an amphibian called labyrinthodont, which lived 200 million years ago in Australia, South Africa and other areas. The new discovery adds fuel to a controversy over a theory holding that Africa, Antarctica, Australia, South America and India were once combined in a supercontinent. It's contended that labyrinthodont didn't swim to Antarctica because animals of this type are thought to have been unable to travel in saltwater.

Seeing or smelling a person causes a dog's temperature to rise from 5° to 7° F. That was established by scientists at the Argonne National Laboratory, Argonne, Ill., who implanted tiny heat sensors and radio transmitters in the abdominal cavities of dogs.

Dome-covered cities offering complete climate control would enable man to live in areas now uninhabited because of weather extremes. That's the belief of a University of Wisconsin researcher who says that it is technically possible to construct domes two miles in diameter and one mile high. (A domed city is actually under consideration for upper Minnesota, where winters are severe.) Main problem foreseen: The enclosed city might echo with nerve-shattering noise.

Boulder tracks on the moon show up on some clear and detailed photos taken by the Lunar Orbiter vehicles. The tracks were made by boulders rolling downhill after being thrown from craters made by recent impacts of meteoroids on the moon's surface. U.S. Geological Survey astrogeologists have counted nearly 300 boulder tracks to date. Studies of the tracks give clues to some of the physical properties of lunar surface materials.

High-flying supersonic transports could add greatly to air pollution by creating a layer of haze around the earth, according to a scientist at the State University of New York, Albany. Supersonic transports now under development, he says, will dump their exhaust into a region of the stratosphere where there is much horizontal air movement but little vertical motion. It has been estimated that 400 supersonic transports, making an average of four flights a day, would spew 150,000 tons of water vapor into the stratosphere.

The use of pooled human plasma should be "discouraged" because of strong new evidence that it often transmits hepatitis. That recommendation comes from the National Research Council, Washington, D.C., and is based on the results of a three-year study in Los Angeles in which 10 percent of patients receiving plasma were hit with acute hepatitis within six months. Pooling—the mixing of plasma from the blood of many individuals—is widely practiced because it is thought to have a neutralizing effect on dangerous antibodies.

Molecular beams may provide the best means for long-distance communication between exploring parties on the moon, says a Yale University professor of engineering. A high vacuum and low gravitational field would allow beams of neutral gas molecules to travel in orbital trajectories and carry information to all points of the moon. Radio waves won't do the job. The moon has no atmosphere and, consequently, no ionosphere that radio waves can be ricocheted off for over-the-horizon communications. ★ ★ ★



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21

Classy Little Corolla

Already No. 5 among car imports, Toyota is about to introduce a little brother to its popular Corona

By ROBERT P. CROSSLEY, EDITOR



TWO-DOOR SEDAN (above) and station wagon will be first Corollas imported. Later there'll be a fastback

YOU'D THINK DETROIT had enough headaches—safety, strikes, smog-control, recalls. Paralyzed by these, it's watched foreign carmakers, led by you-know-who, bounce back to grab one sale out of ten in this country. Now another sure-to-sell import is about to "bug" it.

I'm speaking of the Toyota Corolla, little brother to the Corona which enabled Toyota to move last year from eighth to a virtual tie with Datsun and Volvo for third place in import sales.

I watched it being made in a brand-new factory in Japan last fall. I drove it in California last winter. I don't see how it can miss.

Introduced in Japan about a year ago, the 1077-cc Corolla was rolling off assembly lines at Toyota City at the rate of 13,000 a month when I was there. It will invade the U. S. this month or next. The P.O.E. price hasn't been announced as this is written, but don't offer \$1650 unless you're prepared to drive one home.

Japanese automakers have come a long way in styling since they first knocked on America's door. Some say the Corolla has an Italian look. If so, it isn't pronounced. The Corolla is not as sexy as, say, the Fiat 850. You wouldn't call it exotic, but it isn't exactly square, either.

It shuns the Corona's slanted grille and is as good-looking a car of its size as I've ever seen. The best word I know to describe it is "fresh." You might also add "clean." What it really looks like is what an 1100-cc American car would look like if Ford or GM would get off their tails and design one here and leave off the costume jewelry.

The Corolla is smaller all-around than a Volkswagen, but cheaper and more powerful. From what I saw, it may be as well made, which is still saying a lot.

Its 89.95-in. wheelbase is 4½ inches shorter than a Beetle's, but a fraction of an inch longer than that of a Renault 10. The Renault, however, is nearly 14 inches longer overall and is also wider and higher. In general, the Corolla is a little smaller on the outside than its principal competitors and 160 to 340 pounds lighter.

Despite this, it seems remarkably roomy inside. Big Mike Foss, PM's 6-foot, 5-inch West Coast representative, had headroom to spare. I rode in the back seat and seemed to have more legroom than in some U. S. pony cars. The doors are wide and easy to get in and out of.

The four-cylinder 1077-cc engine produces 60 hp—7 more than VW gets out

(Please turn to page 24)



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CLASSY LITTLE COROLLA

(Continued from page 22)

of 1493 cc and 14 more than the Renault 10 extracts from 1108. I didn't have a chance to test acceleration and top speed, but it cruised the San Diego Freeway at 70 mph with no strain and plenty of power for acceleration off the ramps. Toyota says the top speed is 87 mph. This is really cranking it out when you realize that a VW's top is around 78. This is due, not only to the greater power Toyota wrings from a smaller engine, but to the amazingly low weight-to-horsepower ratio, 25.8 to 1. Compare this with 29.1 for the Fiat 124, 33.3 for the VW 1500, and 33.8 for the Renault 10, and you get some idea why the Corolla is so nimble.

One remarkable thing about the Corolla is that it doesn't *feel* like a little car. You sit fairly high and the hood is long enough to keep you from feeling too defenseless. My wife drove it from Beverly Hills to Pasadena on the freeway. She had never driven the car before and she had never driven on a California freeway, an experience likened by columnist Russell Baker to an infantryman's first exposure to combat. She didn't get lost and she wasn't shaking too hard when she got back.

The Corolla's unusually small turning radius, 29.9 feet, makes it highly maneuverable, and the acceleration Toyota claims for it, 19.7 sec. for 1/4 mile, is faster than that of any other small sedan I know.

The Corolla I drove was one of two in this country last January. It was so new that when we drove it to the Ambassador Hotel to attend a reception for Mr. Tatsuro Toyoda, newly arrived assistant vice-president of Toyota Motor Sales, USA, Inc., a cluster of Toyota dealers gathered around me in the parking lot. They

wanted to know what this new car was.

In three days we found no bugs. Everything seemed to work or fit. The finishing, both inside and out, was first class, and there were no incongruous economies of the sort you often find, even on more expensive European and U. S. cars. The Japanese, not only Toyota, but arch-rival Nissan, have clearly taken aim at Volkswagen. They know that high performance and smart styling give them an edge over "No. 1," but that the real hurdle is to earn a reputation for reliability and quality, and to develop a strong dealer organization with plenty of parts and trained mechanics. They're working on it—Toyota has 750 dealers now—but Wolfsburg wasn't built in a day.

The Corolla's 1077-cc OHV engine is advanced, but no "breakthrough." The four-cylinder, water-cooled, cast-iron block is tilted 20° to the left, permitting access on the right side to sparkplugs, oil-level gauge, distributor, oil filter and fuel pump. Despite its 9 to 1 compression ratio, higher than most engines, it runs on regular gas. The head is of aluminum alloy. The camshaft's high location permits relatively short pushrods.

The Corolla we drove had a manual four-speed transmission, fully synchromesh and easy to shift. A "Toyoglide" automatic will be available.

The chassis is integral, with independent suspension with coil springs in front and semi-elliptic leaf springs in the rear. To the front suspension has been added a transverse leaf spring which acts as a stabilizer.

Although Toyota puts disc brakes on the front wheels of the Corona, it elected to go with drums all around on the Corolla. They seemed adequate enough on the

(Please turn to page 26)

HOW THE COROLLA COMPARES WITH VW 1300 AND RENAULT 10

	Toyota Corolla	Volkswagen Beetle	Renault 10
Displacement	1077	1493	1108
Engine	Front	Rear	Rear
Cooling	Water	Air	Sealed liquid
Main Bearings	5	3	5
Compression ratio	9:1	7.5:1	8.5:1
Horsepower	60 @ 6000 rpm	53 @ 4200 rpm	46 @ 4600 rpm
Top speed	87 mph	77.7 mph	82.6
Miles per gallon	30.5	26.7	31.4
Wheelbase	89.95 in.	94.49 in.	89.37 in.
Length	151.38 in.	160.24 in.	165.24 in.
Width	58.46 in.	60.63 in.	60.8 in.
Height	54.33 in.	59.05 in.	55.51 in.
Weight	1543 lbs.	1764 lbs.	1709 lbs.
Turning circle	29.9 ft.	36.1 ft.	33.8 ft.
Power/weight ratio	25.8 lbs. per hp	33.3 lbs. per hp	37 lbs. per hp
U.S. price (P.O.E.)	(not announced)	\$1699	\$1745

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CLASSY LITTLE COROLLA

(Continued from page 24)

freeway, but from an engineering standpoint, I guess you'd have to give the European competition a higher mark for their front discs, with an A-plus to the Renault 10 and Fiat 124 for discs front and back.

When I visited it last November, the Tanaka assembly plant was not quite a year old. Built to turn out Corollas, plus smaller Toyota 800s for the Japanese market, it is newest of four factories scattered around the rice fields near Toyota City east of Nagoya. Toyota calls it the "world's most modern assembly line." Having seen all three, I'd say it's halfway between Volvo and Volkswagen in automation.

Founded in 1937 by Sakichi Toyoda, owner of the Toyoda Automatic Loom Works, Toyota—the company changed its name because "t" is easier to write than "d" in Japanese, but the family still uses the old spelling—is now the sixth largest carmaker in the world. It is the third largest producer of commercial vehicles. The combined output of all of its plants is 80,000 vehicles a month. It expects to sell about one month's production, maybe a little more, in the United States this year—over twice what it sold here in 1967.

Although Japan overtook West Germany last year to become the No. 2 auto-building nation, it is a Johnny-come-lately on the international automotive scene. Even at home the industry didn't sprout wings until five or six years ago. Prior to that time cars were thought of as "economic assistants." Most of those on the streets were taxis or other commercial vehicles. Country roads were rough, and Japanese cars tended to be big and horsey like, say, a 1958 Pontiac. Well, not *that* horsey, but almost. Eleven years ago the Government suggested that it might be good for Japan to have some low-priced "people's cars" like Germany's VW. The first ones were small, 360-cc or less. They caught on fast. As roads improved, cars got bigger and more powerful. Today's biggest sellers are in the 1000-1500-cc range. Exports to the U. S. totaled 3000 cars in 1963. This year Toyota alone expects to sell us more than 80,000.

The Tokyo Automobile Show is now the world's largest and the Japanese have learned a lot about salesmanship, as witness this from Japan's biggest newspaper, the Asahi Evening News: "Winsome beauties, even including Caucasians, are posted strategically to add an attractive touch." Those Japanese don't miss a trick. ★★



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DETROIT

LISTENING POST

BY BOB IRVIN

ALTHOUGH NEW-CAR TALK is all about the forthcoming 1969s (see pages 64 to 67), industry stylists and product planners have already locked up major changes on the 1970 models. Among the things to look for in 1970 will be really significant changes in the compacts and "sporty" cars. Dodge, for example, is working on a sporty car, a spin-off of what will be an all-new 1970 Plymouth Barracuda. Dodge will keep the Charger, call the new entry the Challenger. Chrysler has a new super engine on tap, too. Reported to be a whopping 480 cu. in., it'll be standard on the Imperial and a couple of the big Chryslers, optional on Plymouth and Dodge. Chrysler's biggest engine at present is 440 cu. in., less than General Motors' 472 (Cadillac) and Ford's 460 (Lincoln). Also for '70—disappearing headlights on American Motors' Ambassador.

SPEED-CONTROL DEVICES (governors, in plain talk), proposed by federal safety officials for all cars, are under heavy fire from the auto industry. In formal replies to Washington, automakers have dubbed the idea ill-advised and unrealistic. One auto official says such a device would be too costly, another that it would invite "back-yard" tinkering—even dare an owner to figure out a way to bypass it. Right now, there apparently is no way to make such a device tamperproof. Don't look for anything along these lines for several years.

PRESSURE TAPE is being used by Ford to mount nameplates and reflectors. Tape is cheaper than metal fasteners, and since holes don't have to be drilled, one source of corrosion is eliminated. The entire industry, very corrosion-conscious these days, is on the lookout for low cost, laborsaving ways to fight rust.

AUTOMATIC HIGHWAYS of the future edge closer to reality every day. Some of these days you will be able to zip along superhighways without operating the controls. This year, for example, Ford will test a computer-controlled Mustang on a special two-mile track laid out near the Massachusetts Institute of Technology campus. It's strictly an experimental project, but Ford is serious; it tested a similar Mustang in Texas not too long ago and the results were said to be "encouraging."

STEAM POWER is being studied by Ford in a new joint project with Thermo Electron Corp., a Massachusetts outfit. The immediate goal is said to be an engine for golf carts (Ready for that?), but Ford has worked out a royalty agreement with the firm regarding future applications of the engine for cars and trucks. Is Ford kidding? Things must look good, because the company has taken an option to buy 20 percent of Thermo Electron's stock.

ONE GALLON per tankful of gasoline is wasted by three out of five motorists, says Champion Spark Plug Co. After checking 400 cars on a portable dynamometer at shopping centers around the country, the company found most cars in need of tune-ups that would give them better mileage and better performance. As cars become more complex, tune-up becomes more critical.

AMERICAN MOTORS' JAVELIN AND AMX have "arrived" in the high-performance field: Hurst Performance Products, Inc., maker of special transmission controls and accessories, now offers a line of shifters and related gear for the new AMC sportsters. Tomorrow the world!

NOBODY'S PERFECT DEPT. Mercedes, the German automaker famed for its well-
(Please turn to page 32)

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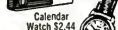
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DETROIT LISTENING POST

(Continued from page 30)

built and engineered cars, recently called back over 2500 units it had sold in the United States to correct a possible safety defect in the accelerator. Cars recalled are the '68 230, 230S, and 250S. Possible bug is a faulty accelerator pump lever, failure of which could cause stalling while you're stepping on the gas.

TIRE FAILURE isn't a big factor in causing auto accidents, according to separate studies made by the Automobile Club of Michigan and the Northwestern University Traffic Institute. The studies showed that no more than 2.42 percent and perhaps as few as less than one percent of accidents were the fault of tires. "No matter how hard we tried," reported one researcher, "we couldn't find much connection between tire failure and accidents."

JEEP STYLISTS have come up with a new convertible in the Jeepster Commando line. The new model differs from the regular convertible thanks to a new roofline and elimination of the "Continental" spare tire. The new roof is characterized by a more slanted backlight and a neater, more tailored look overall. The spare has been moved in behind a hinged tailgate that allows access to cargo space in back of the rear seat.

REFLECTIVE LICENSE PLATES, visible for well over a quarter of a mile in the headlights of an approaching car, can help substantially in cutting down rear-end collisions, report two researchers at the University of North Carolina Highway Research Center. Their studies show that use of reflective plates in North Carolina last year prevented as many as 1000 night-driving accidents.

THE BIG THREE—GM, Ford, Chrysler are rumored to be dead serious about their interest in motorcycles. Main pro behind current thinking about bikes—or "bike-like" vehicles—is the increasing urban, suburban glut of traditionally sized U.S. cars. Pragmatists regarding profits, manufacturers want to be ready to quickly shift product lines should the status quo be threatened. Buying up established cycle outfits may be a first step.

GOLD has replaced white as the favorite exterior color with buyers of new Chevs. The division says over 15 percent of its '68s sold so far have been painted "ash gold." White has been Chevy's top seller for more than 10 years. ★ ★ ★

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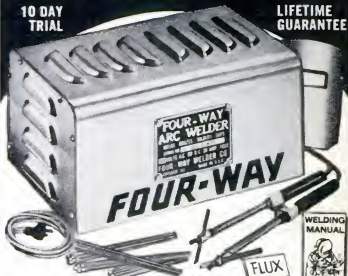
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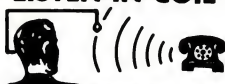
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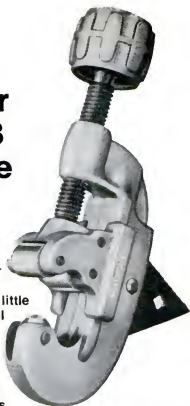
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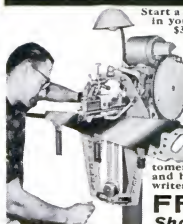
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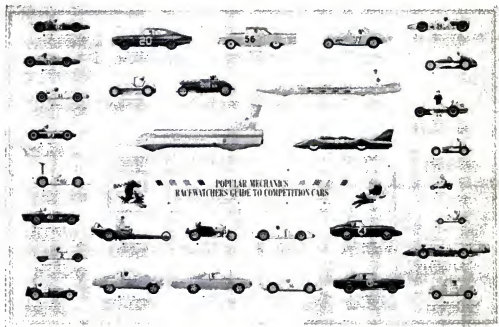
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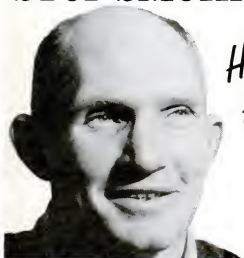
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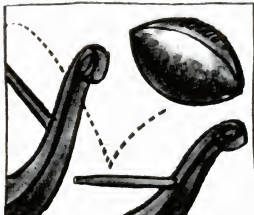
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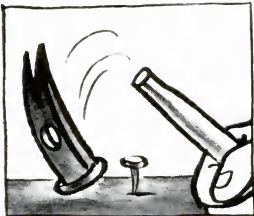
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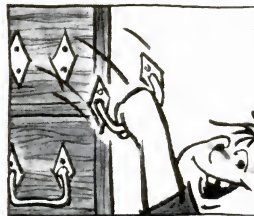
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BY W. CLYDE LAMMEY

When to roll lawns

My lawn is rather rough. Ridges, shallow depressions and low hummocks cause my mower to skip and scalp here and there. I've been advised to roll the lawn, but will this help? The soil seems to be friable, a clay type rather than sandy, and drainage should be reasonably good. I'd like your suggestions.—M.R., Ind.

I'm always hesitant to suggest rolling a lawn on clay soil, or any of the heavier soils. It's possible that a light rolling would do some good by pressing grass plants into closer contact (those that may have been heaved by frost), but this won't level the ridges or fill the depressions you mention. If you weight the roller sufficiently to flatten these irregularities you risk compacting the soil unduly. It seems to me that a better way of handling your problem would be to build up the depressions and level the other areas with new soil applied as a thin mulch and raked lightly to expose the grass blades.

To level the deeper depressions you may have to carry out the procedures by stages, applying several thin coatings of new soil at one-week intervals or between rains.

Ridges can be leveled by cutting and lifting the sod, removing some of the soil thus laid bare and then immediately replacing the sod. At a time when the new soil is dry on top you might roll the entire lawn lightly, using a roller weighted to not more than 30 pounds or so.

Stain to watch

I have a slant-front desk on which the veneer has been chipped off the outside corner of the slant-front. I replaced this veneer with the same kind of wood but so far I have not been able to stain the new veneer so that it matches the old. The stain of the color I want just won't darken the new wood sufficiently. Is there any other procedure I can carry out? The wood is figured maple.—O.D., Kans.

I assume you are trying to match an original shaded finish, which would normally be darker at the corners and along the edges of the slant-front, or drop lid.

(Please turn to page 40)



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HOMEOWNERS' CLINIC

(Continued from page 38)

None of the maple stains ordinarily available is likely to match this color, even if you apply it in full body and allow it to dry without wiping. Probably the best and simplest way to handle this problem is to use artist's colors. Apply the color with your finger just as it comes from the tube and then wipe it off until you have just the right matching shade. This will take some experimenting with mixtures of, perhaps, burnt sienna and burnt umber until you get the combination of the two that will match the original. Be sure to allow it to dry for a week to 10 days before applying any top coat. Artist's colors applied as they come from the tube take a long time to dry.

Hyacinths didn't show

Late last fall I planted hyacinth bulbs but nothing came up this spring. I planted the bulbs a good 6 in. deep in a rather heavy soil and I'm wondering if this didn't compress and prevent the plants from emerging. Is this possible?—M.T., Ohio.

A "good 6 in. deep" may have been too deep, as you suggest. Also, the bed may have been walked on during the winter when the soil was wet. This could be a cause as it may have compressed the clay soil and prevented growth.

Sod or seed on slopes?

My grade slopes so much in all directions from the foundation that, during heavy rains, new seed might wash away. Black soil is well distributed over the area. Should I sod or seed?—L.T., Va.

Sodding (with commercial sod) could be your best bet, assuming that the season cooperates, your budget will absorb the shock and you have time to lay the sod right after delivery.

Be sure the yard is graded as you wish, with no ridges or hollows to interfere with easy mowing. Loosen any compacted areas by raking or spiking, and if the soil requires, give it an application of lime. Lay the sod squares flush, or nearly so, with walks and driveway. Keep them damp and pressed tightly together, and see that the edges are joined flush.

Water as you go and at intervals during the remainder of the growing season when rain does not provide sufficient moisture. Your local supplier is in the best position to advise you about when to supply plant food. (It's usually recommended in late fall.) ★★★

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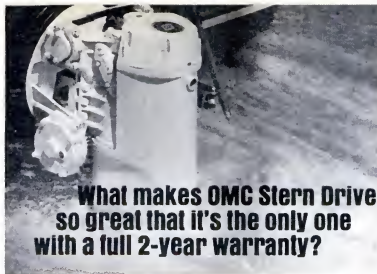
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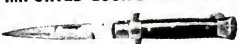


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Gummed-up carbs

I have a 1965 Corvair Monza with a 140-hp engine. My problem is that the secondary carburetors gum up. Do you have a solution?—K.O. Heintz, Houston.

I'll bet you do a lot of city driving. Those secondaries don't open until you reach about half throttle. This means that during slow driving, gas settles and stays inside the carbs; then varnish forms.

I can only suggest that you take off the carburetors, clean them and install the minor overhaul kit Chevy issues. But I wouldn't rely on this alone. It's best to get the car on the open road every so often and drive it hard enough to kick in the secondaries. This will surely get rid of gas before it builds up inside and causes you trouble.

Another pesky PCV

My 1963 Cadillac developed a rough idle problem, loss of power and an increase in fuel consumption. I disassembled the carburetor, cleaned it and put in new parts from a rebuild kit. This cost me plenty of money, but I'd be satisfied if the problem was solved. It isn't. Why?—Phil Freed, Cincinnati.

Because your trouble is probably due to a neglected positive crankcase ventilation valve. Cadillac tells us that at every engine oil change—that is, every 60 days or 6000 miles—the vent valve should be removed and rinsed in carburetor solvent. The shank end of a 3/32-inch drill should be inserted into the threaded end of the valve to clean the orifice on the inside. An air hose should then be placed against the large hose connector end of the valve, and dirt particles blown out. If the trouble isn't solved by cleaning the valve, a carbon build-up inside the engine may be causing the trouble. A carbon solvent is available from a Cadillac dealer.

Screaming steering

I own a 1965 Ford Galaxie 500. To date, four power-steering pumps have been replaced to eliminate a loud howling that occurs when I turn the steering wheel. At first, a new pump seems to get rid of the noise, but it returns after a few

months. Now, the Ford dealer says the pump is good, but I still have the noise. I need your advice.—T.F. Thor, Phoenix, Ariz.

In a way, the dealer is right. The pump is not defective. There's been a history of noise with this power-steering setup, with the howl being traced to the pressure-relief valve. You may have noticed that the noise is greatest when the car and steering are cold, subsiding as they get warmer but never disappearing entirely. Even a new pressure-relief valve issued by the company has failed to stop the noise. You'll have to live with it.

Shop manual typo

When servicing the closed-crankcase ventilation system of my 1965 Corvair 500, I found the orifice in the vent pipe only large enough to insert a No. 53 (.059 in.) drill. According to the engine tune-up chart in my 1965 Corvair shop manual, this orifice should be .089 in. The engine runs normally, but I'm wondering if enlarging the orifice to manual specifications wouldn't increase my fuel performance.—Charles Peters, North Bergen, N.J.

There's a typographical error in the shop manual. The orifice dimensions should read ".059 inches." Enlarging will upset the carburetor mixture and give you a rough-running engine.

Playing the odds

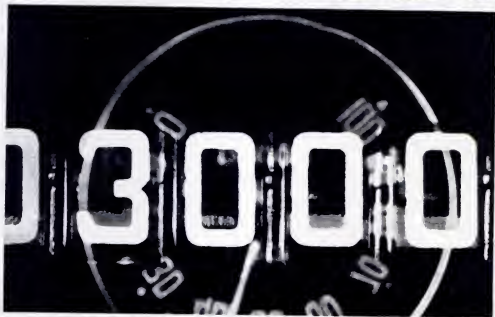
Hope you can settle a dispute. I had a problem with my 1963 Pontiac Hydramatic. The mechanic said he had to replace the governor, which cost \$23. Now, a friend tells me that his mechanic was able to clean the governor of his Hydramatic and put it back into service. The job cost him a couple of dollars. Was I taken?—Frank Booth, Wilmington, Del.

That depends on whether you're in the 80 percent or 20 percent class. Research done by Pontiac reveals that 80 percent of the sticking governors returned for examination could have been cleaned and put back into the car. The other 20 percent failed to operate properly after cleaning. There is, of course, no way of

(Please turn to page 54)



The Round Tire is Mile-ier



It gives you at least 3,000 extra miles

Notice we say "at least." That's what "mile-ier" means. The Round Tire—Atlas Plycron®—has a husky overall construction that helps it roll at least 3,000 miles further than tires that come on most new cars. Once again, road tests against complete sets of tires for new 1968 cars proved it.

One good reason for this extra mileage is the muscular Atlas Plycron tread. It's "tread-ier,"

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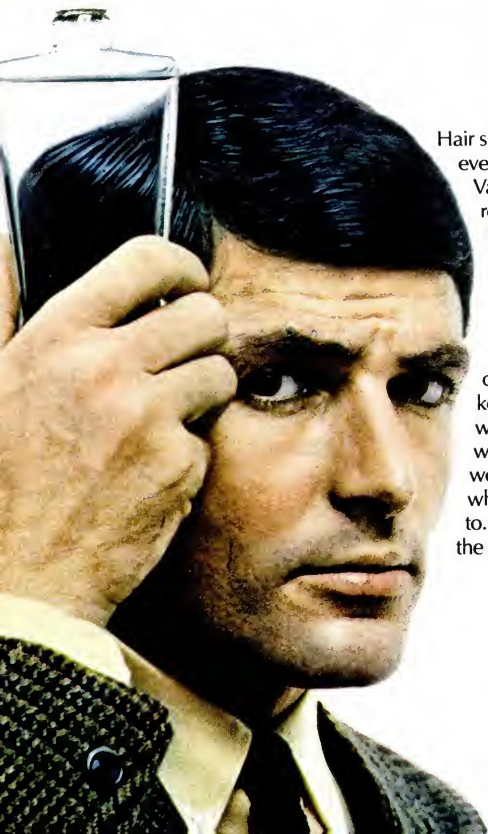
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See the light!



 ...has a better idea.

Smooth, strong Twin-I-Beam.



Roomiest cab of any pickup—and the quietest.



New Flex-O-Matic.



Camper Special models.

AUTO CLINIC

(Continued from page 50)

disputing your mechanic now. But you've got the odds should the trouble crop up again.

A gasser

Just bought a 1963 Valiant for a second car, and I'm ready to turn it back in. I thought I'd get economical transportation with it, but the fuel bills are killing me. Is there anything that I should know before I take the drastic step?—M.K. Carter, Trenton, N.J.

Does it have the original Holley carburetor? Check the number of the carburetor tag against the information below. If it does have the original part, make sure the engine's tuned and adjusted to specification, and then change the main metering jet and increase the idle air bleed one drill size. This will get you better fuel performance.

The following is a listing of the leaner-mixture, air-bleed drill sizes and metering-jet part numbers to use.

Car Model	Holley Carb. Model	Idle Air Bleed No.	Holley No. Main Metering Jet
Valiant 170 Manual	R-2533A	50	22R-40-052
Valiant 170 Automatic	R-2534A	48	22R-40-056
Valiant 225 Manual	R-2535A	49	22R-40-056
Valiant 225 Automatic	R-2536A	49	22R-40-055
Plymouth 225 Manual	R-2537A	49	22R-40-056

Watch it when drilling out the idler air bleed. Do not use a power tool. Simply turn the drill by hand, using a tap handle. Smear the drill flute with grease to catch chips and prevent them from falling into the carburetor.

Putting around

Here comes a blast. In your Feb. 1968 column under the title, Too Much Juice, the man who said his car's backfiring is wrong, especially if as you told him his trouble was caused by an over-rich fuel condition. He's got after-fire. No?—Raymond Cloutier, Plymouth, Mass.

Yes! And I take full blame for letting his term stand. Backfire—a subdued explosion in the intake manifold—is caused most often by a lean mixture, a leaky or sticking intake valve, or current leakage. After-fire (also called stack-firing and after-burning), which is a subdued putt-putting from the tailpipe, occurs when the fuel mixture isn't fully burned in the cylinders and excess is fired by a red-hot pipe or muffler as it makes its way through the exhaust system.

Service Tips

● **Oldsmobile** tells us that if you should hear a buzzing noise from the voltage regulator with the engine running, check the red wire from the positive terminal of the battery to the horn relay. Looseness of the wire at the relay causes the noise and, of course, indiscriminate replacement of the regulator unit. A loose connection can be the result of an oversize screw hole or the use of an under-size screw. Match the hole with the right screw for a good connection.

● **Floor-mounted shifts** for a Chevrolet manual transmission may be causing trouble. Is yours hard to move or stiff? That's probably because the shift mechanism has developed a slight coating or rust. There is only one thing that will protect that mechanism from road splash and the elements—a protective film of water-resistant EP chassis lubricant every time you have your oil changed or chassis greased. If your serviceman says there's no place to put the grease, have him check page 3 of Chevrolet Service News No. 9 (Aug. 1967).

● **A vinyl roof** on a 1967 or 1968 Chrysler car, or any car for that matter, needs specific care. Chrysler tells us they have reports from the field about the color coming off the vinyl covering and that some coverings are becoming sticky. The color is dissipating because of indiscriminate use of commercial solvents and cleaning solutions, and by excess rubbing pressure. When the roof becomes sticky, the company has determined that it's due to application of an unauthorized vinyl dressing. Chrysler won't be responsible if you use or do anything to that vinyl roof which is not stipulated under the vinyl roof-cleaning section of your Chrysler owner's manual. ★★

GOT A PROBLEM WITH YOUR CAR? Ask Mort about it. Send your question to Auto Clinic, Popular Mechanics, 575 Lexington Ave., New York, N.Y. 10022. Letters cannot be answered individually, but problems of general interest will be published in the column.



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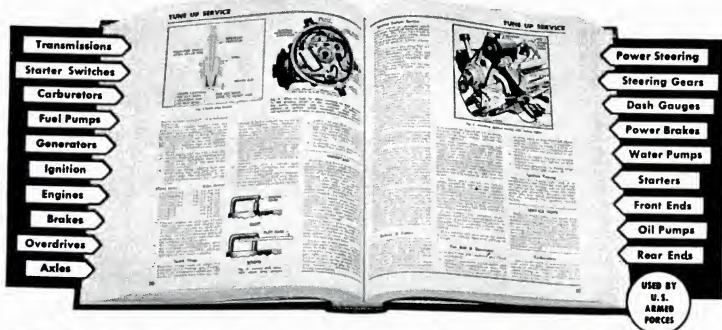
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AMERICA'S SUPERSECRET SPY PLANE

By KEVIN V. BROWN

The Air Force's Mach-3 jet first flew nearly five years ago, but the mystery of its mission lingers on

IN FEBRUARY, 1964, President Johnson announced we had a superspeedy, supersecret jet airplane called the A-11.

In July, 1964, he announced that we had developed a reconnaissance version called the SR-71.

In May, 1965, Air Force pilots, flying a fighter version, the YF-12, set nine speed and altitude records that still stand, including a speed of 2070 mph, and an altitude of 80,257 feet.

All this was three and four years ago.

What ever happened to the A-11? What ever happened to the SR-71? What ever happened to the YF-12? What ever happened to Baby Jane?

Well, Baby Jane is on the Late Show, but the three "Black-birds," as the pilots call them, are still around, still flying, still



KELLY JOHNSON (left), guiding genius behind Mach-3 airplane, created it in great secrecy at Lockheed's famous "Skunk Works"

superspeedy, and still supersecret. It's no secret what a Blackbird *can* do, but it's a definite secret what it really is doing, and a considerable secret why it isn't allowed to do more.

I can clear up one mystery easily. All three airplanes are pretty much the same one. The A-11 is the designation Lockheed Aircraft Corp. put on it, and YF-12 (Y for prototype, F for fighter) and SR-71 (for strategic reconnaissance) are the designations put on it when the Air Force took over.

Lockheed, through its resident genius, Kelly Johnson, developed the Blackbird at its famous "Skunk Works" in Burbank, Calif., and moved it, one piece at a time in hush-hush secrecy, to its isolated "Ranch," somewhere in Nevada. There it was put together and flown before President Johnson's announcements.

With each succeeding skeleton announcement, the mystery deepened.

The YF-12, after it was moved to the Air Force Flight Test Center at Edwards Air Force Base, Calif., set nine new records, all in the same day, all since recognized by the Federation Aeronautique Internationale, and all still standing. They are:

1. Absolute straight-course speed, 2070 mph.

2. Absolute sustained altitude, 80,257 feet.

3. Straight-course speed for jets (same).

4. Sustained altitude for jets (same).

5. Closed-course speed, 1688 mph.

6. 1000-kilometer course (same).

7. 1000-kilometer course with 1000 kilogram payload (same).

8. 1000-kilometer course with 2000 kilogram payload (same).

9. 500-kilometer course, 1643 mph.

One reaction might be that the X-15 has flown faster and higher than the YF-12, which is true. But the X-15 was dropped from a "mother ship," while the YF-12 took off and landed under its own power. The X-15 has never claimed any international records and probably never will.

The second reaction is, "Great! What's the YF-12 been doing since then?"

Nothing—or next to it. It's still at Edwards, still flying test flights, or at an occasional air show, but it's nowhere near going into action.

The SR-71 has fared better. It was assigned to the Strategic Air Command's 9th Strategic Reconnaissance Wing at Beale Air Force Base near Marysville, Calif., in Jan. 1966, but precious little has been said about it since.



TWO BLACKBIRDS, SR-71 (in flight above) and YF-12 (in hangar below), are two versions of same plane. SR-71 is operational at Beale AFB, Calif., but no one will say what it's doing. YF-12 is still being tested at Edwards AFB, and no one knows or will say why it's still there



To clear up some of the mystery, I visited Edwards and was allowed to interview the men who fly the YF-12. A similar request to visit Beale and talk to the SR-71 pilots was courteously, but firmly, turned down.

The YF-12 pilots, in a word, are sad.

Colonel Joseph Rogers, commander of the Air Defense Flight Test Detachment at Edwards, who showed me around the airplane and let me sit in the cockpit, is convinced it would be a great addition to our air defense. "The volume of air we could defend would be expanded considerably," he said.

The plane has a lot going for it.

● It's a quantum-jump breakthrough in performance. Most improvements just

add a few miles per hour or a few feet of altitude. The YF-12 jumped almost a complete Mach number in speed and more than a mile in altitude.

● It can operate in what the Air Force calls a "degraded environment." Current air-defense fighters require ground-controlled support for accurate interception of incoming bombers. The YF-12, with its own on-board radar, computer and inertial navigation, can operate independently at long range even if ground stations have been "degraded"; that is, bombed out.

● It has one of the most sophisticated weapons system going in the AIM-47 (air intercept missile). It carries four internally. Each is ejected downward



SR-71 NOSE is flanged like sting ray, in only outward difference in configuration from YF-12

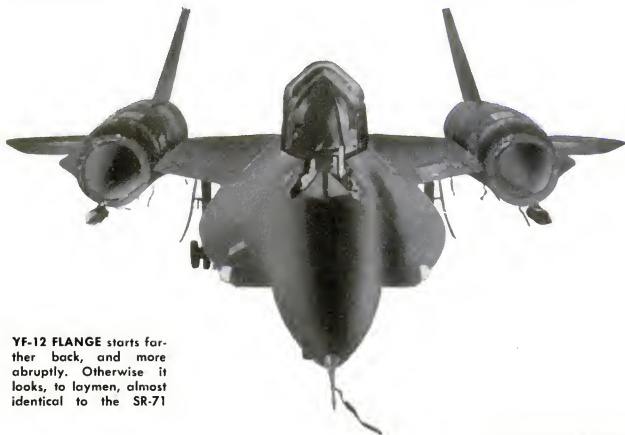
for safe clearance before its rocket charge is fired, then with its proximity fuse it could destroy a fleet of bombers without scoring a direct hit.

Get this picture. The YF-12 travels at 2000 mph, the AIM, when fired, would add another 2000 mph, and if the enemy force were coming in at, say, 1000 mph, there would be a closing rate of about 5000 mph. The Air Force claims that, if the enemy force crossed the northern Canadian border, a YF-12, taking off from El Paso, Tex., could intercept it before it crossed the U.S.-Canadian border.

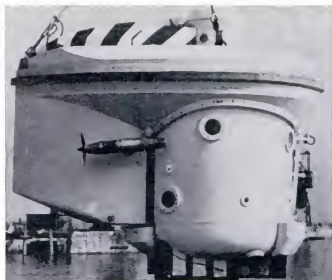
So why isn't it operational? Only God and the Pentagon know, and the Pentagon isn't talking. Best guess is that bombers are less of a threat today than missiles, so there is less need for a 2000-mph interceptor. Meanwhile, our aerial defense is maintained by interceptors, chiefly Mach-2 F-106s, which have considerably less performance capability than the Blackbird.

And the SR-71? This is, by name, a reconnaissance plane—a spy plane—and it has often been tagged a follow-on to the controversial U-2, one of which

[\(Please turn to page 190\)](#)



YF-12 FLANGE starts farther back, and more abruptly. Otherwise it looks, to laymen, almost identical to the SR-71



Bound for the North Sea

A battery-powered, 11-foot-long midget submarine is being used by Britain to search for underwater resources in the North Sea.



Tuneful typing

The laborious task of copying music can now be handed over to a new German type-writer. It was displayed at a Frankfurt fair.



Van puffs itself up

Exhaust from a vehicle's engine inflates this balloon jack, developed by scientists of the Royal Aircraft Establishment.



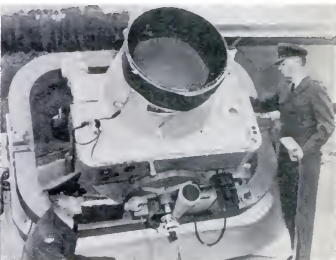
Tank trainer

A duplicate of the Centurion tank turret is used by the Swedish Army to train tank crews. Gun recoil is simulated electrically.



Satellite plan for hotel

Planned for Milwaukee is a 1000-room "satellite" hotel; each tower is connected to the central administrative building by walkways.



Space Brownie

The Baker-Nunn camera, used by NORAD's satellite-tracking network, can photograph a basketball-size object 25,000 miles in space.

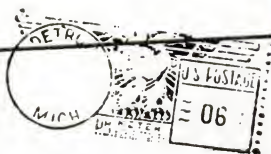
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ADVANCE DOPE On the '69 Cars

Here's a peek behind Detroit's 'iron curtain'
at what you can expect in showrooms next fall

By BOB IRVIN



GUESS WHAT'S COMING for 1969? A Mustang model so wild it looks like something out of the Shelby corral. Also a new Pontiac Grand Prix, already the talk of the auto industry.

These are only two of the many cars now in the final stages of preparation for the 1969 model run. But they will probably draw the most attention when introduced in late September . . . the Mustang because it gets the biggest change since it started the sporty car revolution in early 1964, and the G.P. because it represents a new approach by General Motors in the personal-car field.

There'll be other changes, too, in the sporty or personal car area of the market. The Chevrolet Camaro and Pontiac Firebird will have major styling changes but still retain a strong product identity. Some new designs are needed in the "pony car" market because sales of some models, such as the Mustang, are down sharply this year.

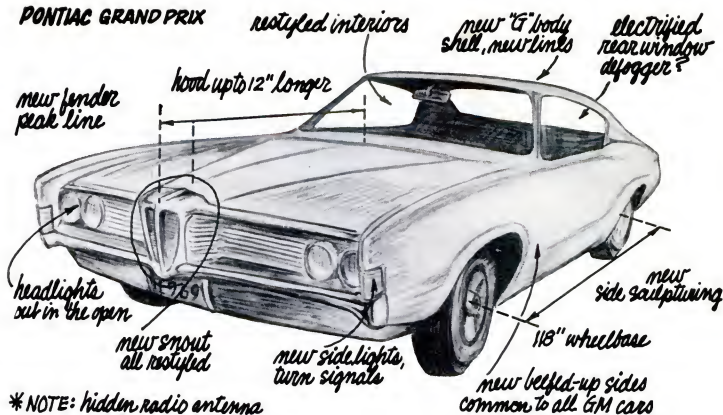
It's also time for a change in the big-car market. These cars have been pro-

portionally less popular just about every year for the past decade. One reason has been the proliferation of other models since the late 1950s—first the compacts, then the intermediates and, lately, the sporty cars. As their popularity grew, the share of the market taken by the standard-size cars declined. It's now less than 50 percent.

At any rate, all the "standards" made by the major auto companies will be quite new next year. This should make them more appealing, just as the intermediate-size cars were this year, thanks to a similar infusion of new styling. Parenthetically, as a result of the 1968 changes, the 1969 medium-size cars will have only minor face-lifts. Likewise, some of the compacts will feature only slight alterations.

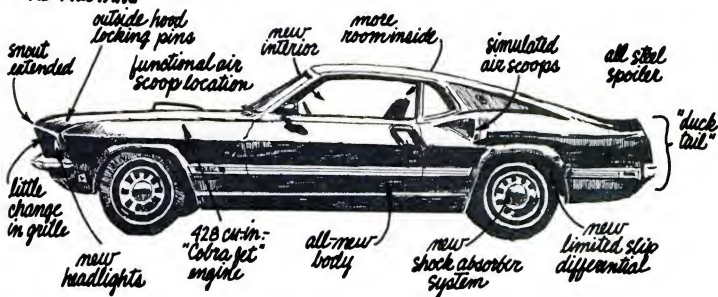
Some of the full-size cars, and the sporty cars as well, are going to be longer. There will be more attempts to streamline—to make the sides appear

PONTIAC GRAND PRIX

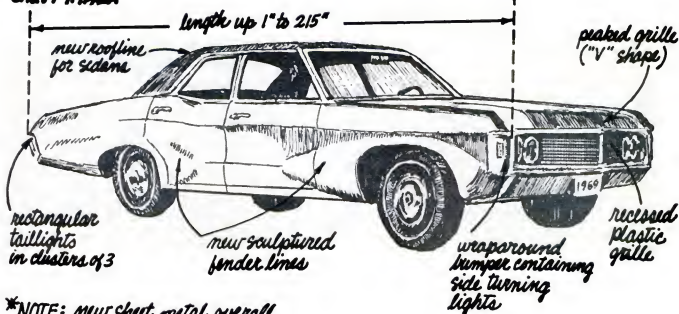


* NOTE: hidden radio antenna

FORD MUSTANG

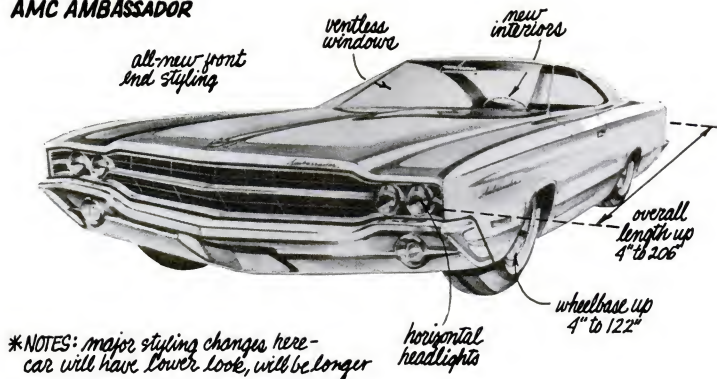


CHEVY IMPALA

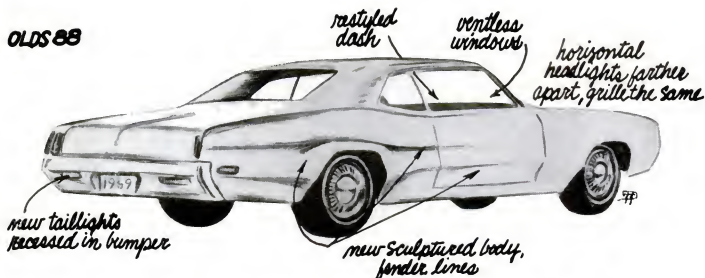


* NOTE: new sheet metal overall

AMC AMBASSADOR

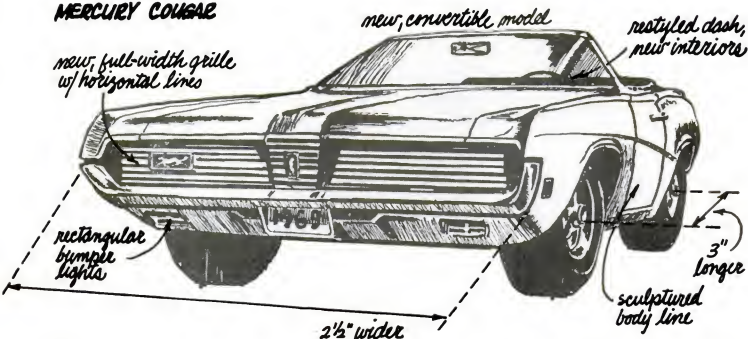


OLDS 88



*NOTES: interiors may be all new - Olds will push handling package

MERCURY COUGAR



rounder. The slab-sided look is being replaced by more sculpturing of the metal, particularly at General Motors. Some of it may look a little odd, but what isn't is that where cars are being lengthened, it's being done more for appearance than function. What good, for example, are four more inches on the hood except to emphasize the sporty-car look?

There will be more use of plastics for grilles and instrument panels. Officials of aluminum companies, who have lost some of this business, still have a hungry eye on the radiator market. But even though there will be more aluminum radiators in use next year, copper continues to be predominant despite the long strike in the U.S. copper industry. Plastic may also be used for some fuel tanks on station wagons. Interior space for three-seat wagons has always been a problem. More space can be found by making the tanks of plastic and shaping them to fit areas underneath the car that couldn't be used previously with metal tanks. There will be more use of rubber bumpers on some Pontiac cars, but no other GM division will yet be using them. GM's competitors are still in the experimental stage on rubber bumpers.

Washington continues to make its contribution to Detroit's annual model change. Federal safety officials have decreed that front-seat headrests will have to be standard equipment after Jan. 1, 1969. They won't be as fancy as the ones now sold as optional equip-

ment, and the firms may not install them until they are required to. This is what they did when shoulder safety belts became standard equipment last Jan. 1. There are few other significant new safety standards for 1969, and no change is planned on the antismog standards until 1970. GM is moving a year ahead of time to install steering column locks on all its cars. They won't be required by federal standards until 1970, but GM is installing them with the start of the 1969 model run.

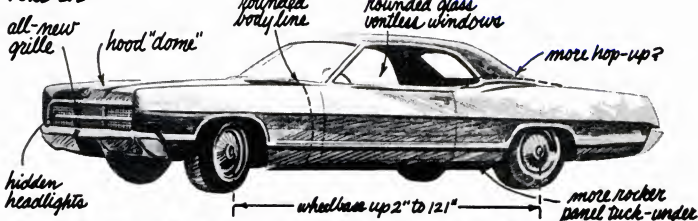
There will be some hidden safety improvements, too. General Motors is working on a way of strengthening the sides of its cars to afford better protection in side impact accidents—the intersection collision so common in cities and on rural crossroads. FoMoCo's standard-sized cars will have energy-absorbing front ends like the collapsible front ends introduced on Ford's 1968 intermediates.

Such things normally don't sell cars, however, but innovations will. Look for several of these in 1969. Included will be a concealed antenna and a rear window carrying electric current for defrosting and defogging.

Competition being what it is in the auto industry, when one car has something, it's not long before the others have it, too. Thus, General Motors will finally come out with two-way tailgates on station wagons, three years after Ford and a year behind Chrysler. On the other hand, Ford and Chrysler still

(Please turn to page 172)

FORD LTD



*NOTE: car goes all-out luxury—may get revised dash, added trim options

NO. 2-BY 21 FEET

Chicago's tapered John Hancock Center will be second only to the Empire State

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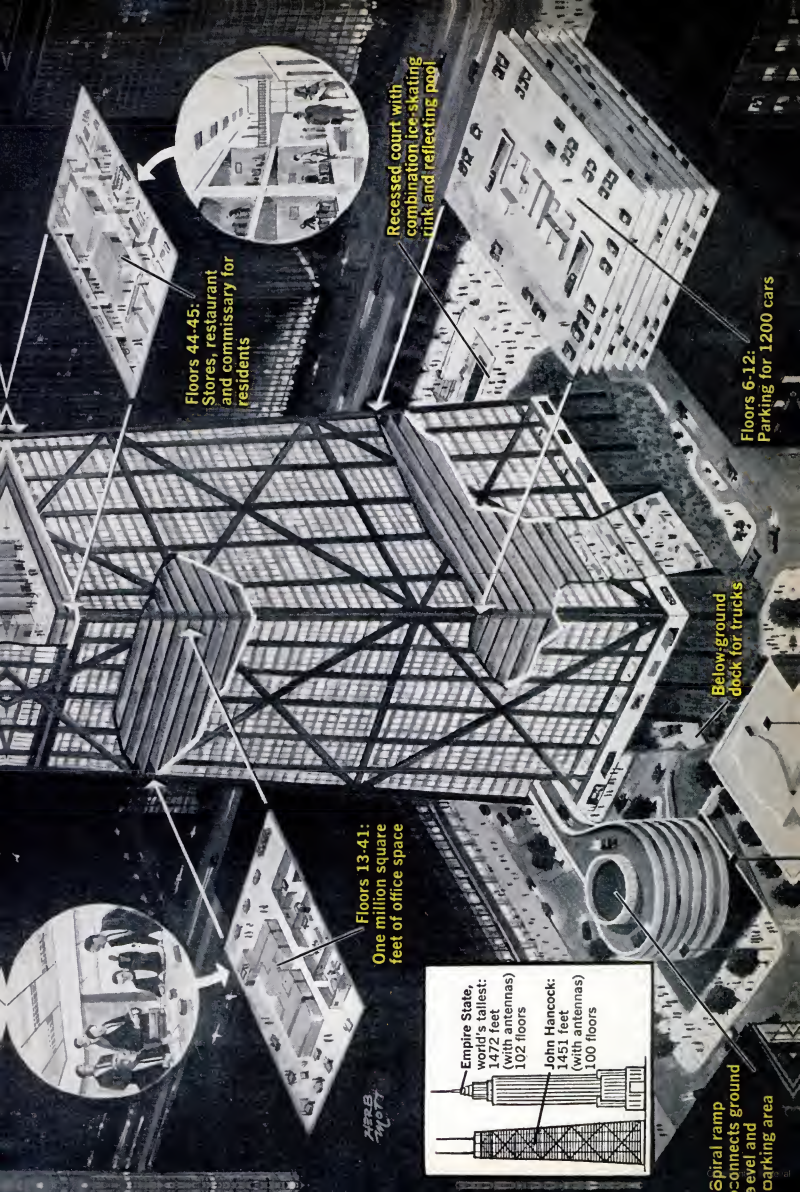
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100 floors

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100 Floors of Modern Living,

By CHARLES REMSBERG

DOMINATING Chicago's skyline today is the most spectacular skyscraper project since the completion of the Empire State Building nearly 40 years ago. When completed late this year, the \$95-million John Hancock Center, blending the worlds of work, living and recreation, will tower 100 stories high and introduce a unique shape to American skylines. This giant city within a city will be a showcase of architectural achievement.

Topping off at 1105 feet—1451 with TV antennas—the multifunction center will be second only to New York's Empire State Building by 21 feet.

Unlike any other skyscraper, its sides will gracefully lean inward, tapering from base to roof. Huge diagonal steel beams a yard thick will crisscross its glassy exterior walls, giving it structural support and making it look somewhat like a forest-fire tower gone wild.

400 miles of concrete

To set the caissons of this building, construction crews drilled the deepest hole ever beneath a building, with the most powerful drill rig ever built. The caissons themselves are the biggest in combined depth and diameter ever used. Enough concrete was poured into the building's substructure to have paved a 400-mile sidewalk from Chicago to Minneapolis. The center's welded exterior frame required 42,000 tons of structural steel—1/10 the total tonnage fabricated monthly in this country. The vast outer surfaces will glisten with the most extensive aluminum-and-glass "curtain wall" installation in the world.

Inside, temperature will be controlled by the world's largest all-electric heating and cooling system; the building will consume enough electric power daily to supply a city of 30,000. The world's fastest automatic elevators will whisk passengers from street to sum-

mit in 39 seconds and allow apartment dwellers who also work in the building to "commute" to their jobs in less than a minute. Even the building permit cost more than any other in the city's history—a cool \$89,239.30 in all.

This amazing landmark is largely the brainchild of Bruce Graham, a lean, soft-spoken architect who, at 41, says he has designed "more office buildings than anyone else in Chicago." The location of the building site, in an exclusive shopping section of Michigan Ave. called the "Magnificent Mile" between the city's expensive Gold Coast residential area and the Loop, dictated that the Hancock Center should combine office and living space, Graham says.

Initially, he thought of two buildings, one a 45-story commercial, the other a 70-story residential, linked by shopping malls. Then after discarding some 30 designs, he hit on the idea of "stacking one building on top of another." This will prove more economical because the center will be occupied around the clock, with some 8500 persons drawn there to work during the business day and about 1600 enjoying their efficiency-to-four-bedroom apartments there at night.

A single building, Graham discovered, would leave roughly 60 per cent of the block-square site unoccupied. The unused space, to feature a 50,000-sq.-ft. plaza of travertine marble and a sunken reflecting pool that will convert into an ice rink in winter, will create "a great psychological feeling of openness," the architect says—a desperate need in today's crowded cities.

Computer designed

The skyscraper's trapezoidal design, which Graham worked out with the aid of three computers, will add to this sensation. The radical taper also will effectively accommodate the requirements of the building's varied uses.

Working and Recreation

Illustration by Herb Mott

"Apartments," Graham explains, "want relatively narrow space, say 20 feet from the inner walls to the window. In offices, efficiency increases in proportion to the depth from core to exterior wall, from a minimum of 30 feet to a maximum of about 50. Automobile parking in a building like this takes about 60 feet around the core, allowing for two parking areas and a driving lane. Commercial operations need as much open space as they can get."

Separating the work and living levels and open only to tenants and their guests will be a unique Sky Plaza, a two-story layout of boutiques, service salons, a laundry, a mail center, a year-around swimming pool and a health club. Uppermost floors will house clubs, the restaurant, the observation area and mechanical equipment.

A trussed box

In addition to its unique taper, the mammoth tower's most startling architectural element will be the steel diagonals, five and a half gigantic Xs pyramiding up each side of the building. These are not mere ornaments. "Besides lending a sense of scale, the diagonals distribute the vertical load silo-fashion," Graham explains. "Wind stress is taken on the exterior, too, and the building becomes in effect a trussed box stood on end."

By eliminating the inside columns, this design is cutting construction costs by an estimated \$15-million. Conventional skyscrapers require at least 45 pounds of steel per square foot, but the Hancock giant, which will weigh 384,000,000 pounds when finished, needs only about three-fourths that. (The heaviest single steel members will be the four 39-foot corner columns, weighing in at 99 tons apiece.)

The biggest skyscraper since the completion of the Empire State Build-

ing in 1931 demands the muscle and imagination of a 1500-man army every working day. Some pieces of equipment they're using are the answer to a sidewalk superintendent's daydreams.

For instance, the taper design meant that orthodox cranes mounted atop the rising building would need enormously long booms to reach out beyond the base and pluck loads of steel off the ground. So, dominating the placement of steel, which pours into the site at the rate of 21 truckloads a day, are four clinging "creeper cranes" of the type used in erecting St. Louis's Gateway Arch.

Now in use on a skyscraper for the first time, the 110-foot-high creepers, topped by 40-ton stiff-leg derricks with 105-foot booms, are inching up each side of the Hancock skeleton. Held snugly to the building by high-strength connecting pins, the specially designed, rolled rigs erect three floors of steel, then are "jumped" to a new height by powerful electric hoists that winch them along guide beams.

Glass for 1300 homes

When the world's tallest office-apartment building is finally a reality late this year, its steel structure will be sheathed in black aluminum and accented with bronze-tinted, glare-resistant windows. The job will take enough aluminum to blanket a dozen football fields and enough glass for 1300 homes.

Solving the problems of this 100-story Goliath is vital to the life of tomorrow's cities, Graham believes. "Urban transportation is fast becoming a crisis," he explains. "Buildings designed like this that offer the amenities of life under one roof and house people within an elevator ride of where they work could be the wave of the future. They could go a long way toward keeping our cities from strangling in traffic."

★★★



New aircraft instrument turns night into day

Pilots flying at night can have a bright-as-daylight view of terrain ahead of them through the foot-square screen of Kollsman's new Night Window. The instrument (photo, left) includes a highly light-sensitive TV camera and optical focusing system. The screen (at right in a simulated installation) makes objects appear life-size and three-dimensional.



SRN-4 goes to sea

In her first sea trial, the SRN-4, largest hovercraft in the world (see page 108, Feb. PM), skimmed over the waves at 60 knots. Twenty-eight passengers were on board for the trials, though the craft will carry more than 250, plus 30 cars, in ferry service.



Not-so-private eye

The Army's Medical Research Lab at Edgewood, Md., uses television to measure variations in the size of the pupil of an eye. As a camera focuses directly on the eye, an enlargement of the eye appears in the monitor where it's easily measured on a scale.



Canadian rescue vehicle can go anywhere

Built specially for rescuing the victims of air crashes in the oozing mudflats beyond the dikes of Vancouver's International Airport, a new rescue vehicle can traverse water, mud and rough terrain. The Department of Transport worked with Alpine Distributors to convert a Bombardier Muskeg tractor into the rescue vehicle. The 20-foot, 190-hp tracked vehicle carries rescue equipment in its hull and can hold up to 20 people on its flat deck.



The little engine that could—and does

Engine No. $\frac{1}{3}$ is the pride of Fire Station 70 in Malibu, Calif. Just 10 feet long and 4 feet high, the engine is a midget compared to the regular fire-fighting equipment. However, it's actually used on some calls—it fights fires just like the big ones.



No thoroughbred—but fast

The Street Metisse is a new cycle designed by Britons Don and Derek Rickman. They supply the frame; buyer adds stock parts. It'll do 120 mph with a Triumph engine.



Made unsound by sound

This reverberation room at the Royal Aircraft Establishment is used to test the metal fatigue caused by sound (fed by loud-speakers) on aircraft components in the room.



Energetic egg

This model at the University of Utah gains propulsion from the friction-energized air (or water) through which it passes by sucking it in near the rear and pumping it out.



Instant roads

A hard, fiberglass surface can be laid over sand at 40 feet a minute by a new Boeing process. A fiberglass mat rolls out flat and is sprayed with two resin solutions.

It Goes Great Guns, But, Oh, That Ashtray!

By BILL HARTFORD, Associate Auto Editor

Photos by Irving Dolin



IS IT POSSIBLE? A long-dreamed-of, troublefree car capable of filling everyone's imagined Great Garage in the Sky? At last, a volume production automobile so distinctively designed, so superbly engineered, so immaculately crafted, so impeccably primed and painted, so polished, so painstakingly appointed—and anointed—that its biggest fault, discerned by hundreds, is the design and location of the ashtray?

No. The automotive millennium has not yet arrived. But, incredibly, that ashtray (!) is the top-ranking complaint on the lists of what owners dislike, and what they'd like to see changed on their Plymouth Belvederes, Satellites, Road Runners and GTXs. It overshadows dissatisfaction with workmanship, lack of headroom, squeaks and rattles, wind noise, water leaks and the dozens of other bugs and goofs owners criticized less frequently.

What's wrong with Belvedere's booby-prize ashtray? Owners give a clue: "I like my car. My only real complaint is the ashtray. It must have been designed by a nonsmoker!"—Rhode Island Navy chaplain. "Ashtray bad for smokers, but makes Mr. Nader happy, I suppose."—Minnesota construction company V.P.

► That's because the ashtray is recessed into the dead center, underside of the dash. It doesn't slide out. It's covered by a vertically sliding door.

It may not protrude, but it's still not safe, says a Kentucky farmer: "It's in the wrong place. You can't hit it unless you take your eyes off the road." Furthermore, "You have to take your eyes off the road too long to deposit ashes."—Wisconsin telephone com-

pany foreman. Not only that, "It's almost impossible for anyone with large hands to stub out a cigaret."—Virginia Navy technician. "It's hard to see and reach."—Florida housewife. "It's hard to empty," says a Nebraska architect. And "You can't get it out without spilling contents all over the console," sighs a Virginia plumber.

A young woman in Tennessee who's an ammunition production employee, probably never noticed the ashtray. If she smokes, she probably doesn't when she's behind the wheel: "I enjoy racing, that's why I appreciate my Satellite and all its features . . . I've had cars on the tracks at Santa Ana and Riverside so I can appreciate the handling, which is good at high and low speeds, and it holds the road better than any other American car."

A machinist in South Carolina says, "The handling qualities of the car are fantastic." He had traded in a Belvedere for a GTX with the 440-cu.-in. Magnum engine. A contractor in South Carolina, who has a 426 Hemi engine, likes the acceleration but doesn't like the fact that after only 8000 miles of driving, he's noticed "tire wear is quite fast."

► **I wonder why?**

A bookkeeper must be warming up the roads of Oklahoma with her 440-

powered slicks. She likes the "150-mph speedometer and the loud idle of the engine." A Wisconsin palletizer operator has proven that his GTX is "very quick in a quarter mile, and it's got good speed at the top end." He can compare his performance with a Kansas farmer's "115 mph standing quarter mile!"

► **The 426 with its two 4-barrel carbs churns out 425 hp @ 5000 rpm; the 440, 375 hp @ 4600 rpm.**

Not quite as exciting, but still requiring nerves of cold-rolled steel and skill far above that required to pass a typical kids'-stuff state driver's test, is doing battle behind the wheel of a cab on a city street. A Kansas taxi warrior has a barnful of Belvederes, '68s, '67s and '65s. As he says, "I've got about 1000 miles on the '68s, 140,000 on the '67s and 175,000 on one '65. The Plymouth Belvedere is far superior for cab service to any other car. It's easy to drive in traffic. I can run them up to 150,000 miles with very little mechanical failure."

Phenomenal service wasn't in the cards for a Massachusetts automobile mechanic, however. On a trip to California, he racked up a good number of miles, enough to give his car a real shakedown. "Perhaps I'm so critical because I work on cars five days a week,

STYLE SELLS ROAD RUNNERS and other models in Belvedere series. Later on, owners discover great handling





FORWARD-HINGED REAR WINDOW, which angles out slightly, receives mixed reaction from owners



DRIVER'S-EYE VIEW of instrument panel and controls. Bugaboo ashtray is to the right of Hurst stick



TOP-HINGED GLOVEBOX DOOR, which limits access to minuscule space inside, unhinges Belvedere owners

but my troubles have been lifter noise, heat-riser noise, electric windows inoperative, clean-air package not adjusted right, temperature gauge inop-

erative, not to mention workmanship."

The workmanship criticism applies primarily to the interior. As other owners tend to agree: "I think mechanical workmanship is outstanding, but interior workmanship is poor."—North Carolina technician. And a Virginia accountant, owner of a Road Runner, types, "Outside: beautiful," and then, switching to the red ribbon on her typewriter, "Inside: cheap."

Complaints about the inside of the car are for the usual "screw missing here or there; loose, poorly fitted molding and trim" and so on. A clerk in Virginia, however, complains about a specific problem: "The rear seat slopes way back—very uncomfortable . . .

DRIVING POSITION IS COMFORTABLE but some say rear-view mirror is too low, dashboard's too high



not enough padding—springs stick up and rub your bones.”

Regarding interior design (aside from the ashtray) owners note that the top-hinged glovebox is clumsily designed. Things spill out, you can't place drinks on it and the opened door makes the box almost inaccessible, remark owners who dislike it. Some shorter owners find the top edge of the dash too high, and one wants it really lowered—so his children can see over it.

But, outside, the Belvedere is okay. “Looks good, no garbage hanging on it,” says a Florida electrician. And “It's got class, a look that isn't ignored,” brags an Iowa factory worker.

When it comes time for those dealer trips for routine service or—dreaded word—repair, Belvedere owners seem to be no better or worse off than most of us. With stiff upper lip they roll in, or occasionally get towed in, ready to accept what the fates have in store.

PLYMOUTH BELVEDERE FUEL MILEAGE CHART

PERCENT OF OWNERS	38%					
	24%					
	6%					
	MPG					
318 cu.-in. V8	10.2	12.7	15.2	17.7	20.2	
LOCAL DRIVING	12.8	15.4	18.0	20.6	23.2	
383 cu.-in. V8	6.9	9.4	11.9	14.4	16.9	
LOCAL DRIVING	9.7	12.2	14.7	17.2	19.7	
LONG TRIPS						

ECONOMY isn't big concern of most owners. Only 20 percent of total have 225 Sixes and 273 V8s

One owner, a stock clerk in Wisconsin, says he's lucky enough to have two dealers in town “because one of them I wouldn't take a tricycle to!” ★ ★ ★

Summary of 1968 Plymouth Belvedere Owners Reports*

Total miles driven: 1,189,950

Average miles per gallon:	
225-cu.-in. Six, local driving	17.2
long trips	n.a.
273-cu.-in. V8, local driving	15.7
long trips	18.6
318-cu.-in. V8, local driving	15.2
long trips	18.0
383-cu.-in. V8, local driving	11.9
long trips	14.7
426/440-cu.-in. V8s,	
local driving	10.8
long trips	13.9

Specific likes:	
Handling	53.7%
Style	43.7
Performance	25.8
Economy	25.8
Power	21.4
Ride	20.5
Comfort	19.7
Roadability	10.0
Steering	6.1
Brakes	5.7
Room	4.8

Specific dislikes:	
Ashtray location	22.7%
Workmanship	17.7
Wind noise	13.8
Glove compartment door,	
size	13.3
Carburetor	8.3
Squeaks/rattles	7.7
Rear-view mirror position	6.1
Economy	5.5

What changes would you like?	
Ashtray size and location	25.5%
Glove compartment door	10.8
Workmanship	10.2

Dash: lighting/layout/	
height	10.2
Better quality material	6.2
Rear view mirror position	6.2
Position of front seat locks	4.0
More headroom	4.0

Model:	
2-door coupe	71.4%
4-door sedan	18.5
Station wagon	8.1
Convertible	2.0

Engine:	
225-cu.-in. Six	10.0%
273-cu.-in. V8	10.4
318-cu.-in. V8	41.2
383-cu.-in. V8	20.8
426/440-cu.-in. V8	17.6

Transmission:	
3-speed manual	6.4%
4-speed manual	9.6
Automatic	84.1

Had any mechanical trouble?	
No	51.0%
Yes	49.0

What kind of trouble?	
Carburetor	29.8%
Brakes	10.5
Transmission	9.7
Electrical	9.7
Heater	7.3
Alternator	6.5
Choke	5.6

Dealer repair satisfactory?	
Yes	64.7%
No	26.7

Why the Belvedere?	
Style	47.2%
Past experience	23.0
Price	19.6
Performance	14.0
Size	10.6
Handling	9.4
Economy	8.1
Reputation	7.7
Is the Belvedere your only car?	
Yes	50.8%
No	49.2

Other cars owned:	
Plymouth	22.0%
Chevrolet	21.1
Ford	13.0
Chrysler	12.2
Volkswagen	8.1
Valiant	6.5
Pontiac	5.7
Dodge	4.9
Oldsmobile	4.1

What options/accessories?	
Power steering	68.7%
Radio	63.6
Airconditioning	24.7
Power brakes	20.5
Power top (convert.)	20.0
Positraction	17.7
Power rear window (station-	
wagon)	15.0
Tinted glass	14.6
Courtesy lights	13.6
Console	13.1

Age distribution of owners:	
15-29	44.1%
30-49	34.4
50 plus	21.5

*Where applicable percentages may not equal 100 percent due to rounding and/or insufficient sample.

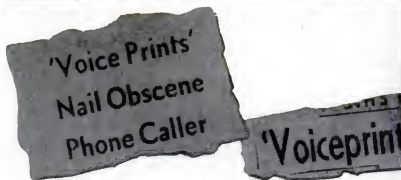
The Thousand Ears Of Soundprints

By FRANK A. TINKER

AT THE HEIGHT of last summer's brief Mideast war, alert Israeli agents picked up a garbled phone conversation that, when deciphered, appeared to be an agreement between the heads of two Arab states to blame the bombing of Egyptian airfields on U.S. and British planes. The agents rushed a tape of the conversation to a London newspaper, which quickly consulted Lawrence G. Kersta, an expert voice analyst and former Bell Telephone physicist here in the United States. Kersta ran the tape through a machine called a sound spectrograph and, as the next day's headlines blared, one of the two voices was, indeed, that of President Nasser of the United Arab Republic.

How could Kersta be sure? Like fingerprints, every voice has its own identifying characteristics determined by unique habits of speech and differences in the voice-producing apparatus—the larynx, tongue and frontal mouth

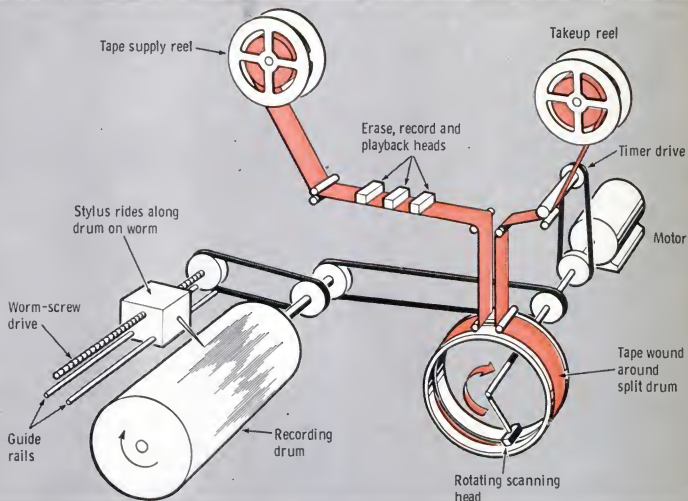
TAPING A SUSPECT'S VOICE, like fingerprinting, is now standard procedure at many police stations



cavities. These identifying characteristics not only vary as much as fingerprints between different people, but they're also just about as indelible. No amount of holding your nose, whispering or trying to change the sound of your voice can camouflage the characteristic pattern.

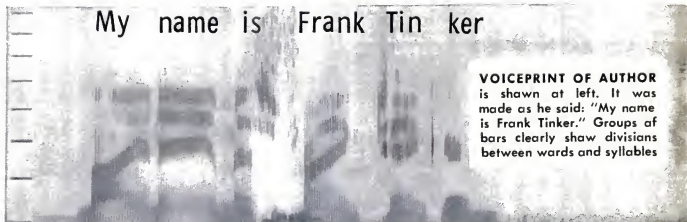
Kersta's sound spectrograph makes a printed time-frequency-amplitude

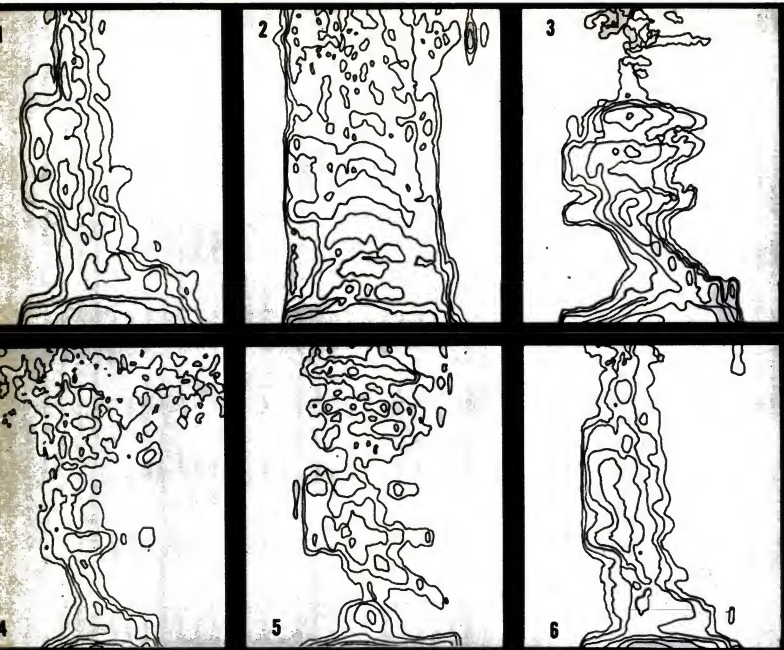
Telltale sound pictures—as distinctive as fingerprints—are catching criminals by their voices. Soon they'll spot diseases, detect mechanical failures before they happen and keep tabs on just about anything that makes a noise



HOW A VOICEPRINT IS MADE is shown above. Tape of voice is wound around split drum. Rotating scanner inside picks up signals from the tape and relays them to a stylus that draws a graph of the voice on a revolving cylinder. Across the page is famed voice analyst L. G. Kersta with his sound spectrograph

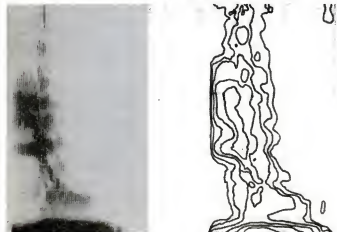
Leads to Arson Indictment *Voiceprint Allowed as Evidence; Ruling Called First of Its Kind*





CAN YOU SPOT the two matching voiceprints above? All six represent the word "you." They were made by five different people with one person speaking the word twice. (Nos. 1 and 6 were made by the same person. While not absolutely identical, they show similar characteristics in the way contour lines are grouped)

TWO TYPES OF VOICEPRINTS are shown below. In bar graph at left, differences in intensity are indicated by variations in shading. In contour type at right, points of equal intensity are connected by lines like a contour map. Bar is easier to read by eye, but contour is better for computer analysis



plot of voiced sounds recorded on magnetic tape. Each plot, or voiceprint, is actually a picture of a person's unique speech pattern. In the case of the suspected Nasser conversation, all Kersta had to do was compare voiceprints made from the Israeli tape with those made from recordings of known Nasser speeches. The prints were found to be identical in 23 different phonetic elements, or points as they are called in fingerprinting. Ordinarily, identification is considered positive if at least 16 points match. By contrast, only 9 to 12 points are required by varying state laws for fingerprints.

Research on voiceprints was begun more than 20 years ago by Bell Telephone scientists as a means of tracking down obscene and threatening telephone callers. Today, the amazing sound pictures are finding impressive uses in an increasing number of fields, including space technology, medicine and industry. Kersta now heads his own sound research company, Voiceprint Laboratories, Inc., in Somerville, N.J., and scarcely a day goes by that he isn't called upon to make some sensational identification.

Following the Watts riots three years ago, a youth interviewed on a TV broadcast brazenly told exactly how he had fire-bombed homes and stores. Although the network had promised him anonymity, appalled Los Angeles police eventually collared a suspect whose record indicated he might be the same youth. Many points of identification were established, but the clincher was the voiceprint. Kersta spotted 33 points of similarity between the suspect's voice and the voice on TV. His testimony helped convict the arsonist.

The first court acceptance of such identification came last year in White Plains, N.Y., when a bribe-taking police officer's voice was trapped by voiceprint. Since then, several other courts have admitted these prints as evidence. Several law-enforcement agencies, including the Michigan State Police, are already requiring criminals to have their voices taped at the time they're booked in the same manner that fingerprints are taken.

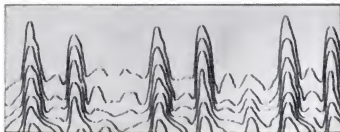
To identify a voice, a sound spectrograph operator chooses 10 simple key words such as "to," "me" and "it." The tape to be scanned is advanced on reels until the section containing a selected phrase is looped around a small drum. A magnetic pickup head rotating inside the drum scans this part of the tape for frequency and volume. The tape is scanned 400 times in 80 seconds as the pickup whirls around.

A deep bass singer can rattle his vocal cords at about 76 cycles per seconds. A coloratura soprano striking a high C will send out 1024 cycles. The

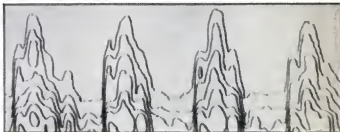
(Please turn to page 176)

How Soundprints Can Help the Sick

HEARTPRINTS HELP DOCTORS to diagnose ailments not readily detected otherwise. Print at left below shows normal heart, while one at right reveals pulmonic stenosis (constriction of pulmonary artery). To the ear, this and aortic stenosis sound alike, but precise soundprints easily distinguish between the two problems



NORMAL HEART

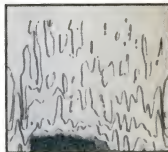


DISEASED HEART

WHETHER A TREATMENT is working or not can be quickly seen by comparing soundprints. Pair at left below shows inhale-exhale cycle of an asthma sufferer before treatment. Pronounced peaks near center indicate typical wheezing, gasping sounds. Prints at right, made after treatment, show wheezes have subsided



BEFORE TREATMENT



AFTER TREATMENT



ONLY PADDLES, oars, and sail may be used, so canoes are favored. Below is the winning canoe. Note oarlocks



Down to The Sea In Ships— The Hard Way

By TOM BUCKNER

In the world's toughest canoe race, rugged boatmen strain day and night to paddle down 419 miles of river and through 50 miles of open sea.



LOW BRIDGE (left) forces contestants to lie out flat. Bridge clearance also restricts canoe height. Eight dams from 5 to 12 feet high cause trouble (above). More trouble (below) as a canoe swamps in one of many rapids. Contestants must carry all their provisions from the start of race. They cannot be supplied along the way. This rule is considered in race strategy

EARLY THIS MONTH, a group of hearties will brave the dangers of river combat in what is billed as "the world's toughest boat race." Called the Texas Water Safari, this year's race may last seven days.

Last year, 37 teams started at San Marcos, Tex., traveled 410 miles down the San Marcos and Guadalupe rivers, then struck out over 128 miles of open water in the Gulf of Mexico. Eight days later, only six teams reached the finish.

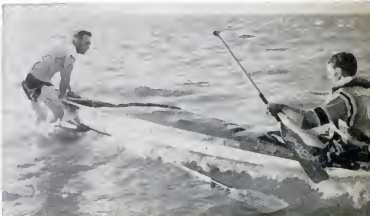
For the second straight year, two tugboat builders, Jay Bludworth, 52, and his brother Harold, 46, won. This was the most grueling Safari in its five year history.

With temperatures soaring to 100° several times, the teams slipped, carried, pushed canoes over eight dams, under 13 low bridges, around countless log jams, through many rapids.

The race will test boat design, race strategy, human endurance. ★ ★ ★



LAST LEG of Safari is a tough stretch of open water in the Gulf. Racing is limited to daylight hours here





AMPHICAT "swims" with ease, making it great for fishermen, duck hunters. Freeboard is ample in deep water

A Cat for All Seasons

PM'S auto editor tests a tough little amphibian that's eager to go just about anywhere

By BILL KILPATRICK

I'M BEGINNING to get the idea the Boss is trying to tell me something. Like, maybe I ought to update the old resume and start looking around for work.

Two years in a row now he has had me out in the boondocks of Michigan in November test-driving some kind of amphibious vehicle. First it was a coolish military prototype called TASC (See *Boy, If It Could Only Fly!*, page 118, Mar. '67 *PM*), then a maximum fresh air job called the Amphicat, winner of a *PM* award at last year's International Inventors and New Products Exposition. My feet got soaked both times and I damn near froze to death. The traditional pink slip would be more humane.

But, subsequent sneezes aside, be-

lieve me when I tell you I had a great time fooling around with that Amphicat. It's the sort of vehicular toy small boys dream of and grown men turn to with the satisfying seriousness they once expended on the pursuit of girls.

For openers, the Amphicat will go just about anywhere. I romped (yeah, romped) over fields, through tall swamp grass, down fire trails, up steep hills (fully loaded, the 'Cat will take a 45° grade in stride), over fallen logs, through marshes, across ponds, through thick woods, under heavy overhanging brush—anyplace following my ample nose took me. Once confidence surmounted craven timidity, I scouted the landscape for obstacles or terrain the 'Cat couldn't handle. No

such; it really is a "go-anywhere" rig.

Key to the Amphicat's outstanding agility is a unique arrangement and type of six tubeless, punctureproof tires, made by Goodrich and called Flex-a-Wall. Power from the 16-hp, two-cycle single-cylinder Sachs engine (from Germany; motorcycles, and all that) is distributed equally to all six wheels via a multiclutch, chain-drive setup. In rough going, the tires flex to cope with whatever presents itself, their action being similar to that of a tank track. On water, the moderately ribbed tires serve as paddle wheels, enabling you to bob along at a brisk two mph.

Rugged performer with plastic body

Another key to the 'Cat's versatility is its deceptively rugged construction. Your first impression is of a frail little bucket you know darn well is going to kill you. Lifting the "hood" and peering down at the maze of engine, gears and chains serves to further your conviction that driving it calls for bravery second only to that displayed by the Wright Brothers. Yet once afield and the adrenalin subsides, you appreciate that the 'Cat's saucy little two-piece molded plastic body is designed and built for a lifetime of hard knocks. The engine apparently has a heart of spring steel and the gear/drive-chain arrangement seems built to survive even the most ham-handed demands of unskilled and unreasonable operation.

Much simplified, driving the 'Cat is something like what I imagine it would be to drive a bulldozer.

There are two speeds—one forward, one reverse. Gears are changed by means of a floor-mounted shifting lever. Driving controls consist of two side-by-side "sticks," the right one of which incorporates a squeeze-type hand throttle. In forward gear, give 'er a little gas, push both sticks forward evenly, and you go forward. Wide open in this position you can reach a top speed of about 35 mph. Ease off on the sticks and they return

to neutral, slowing you down. Hauling the sticks all the way back (again, evenly) will give you braking action. To back up, you put the gear shift lever in reverse and repeat the process; i.e., you push the sticks forward to go in the desired direction.

To turn to the right, you haul back on the right stick and shove the left stick forward. You do the opposite to turn left. The harder you haul and push, the more sharply you'll turn. It takes a little getting used to, but with practice becomes sort of second nature.

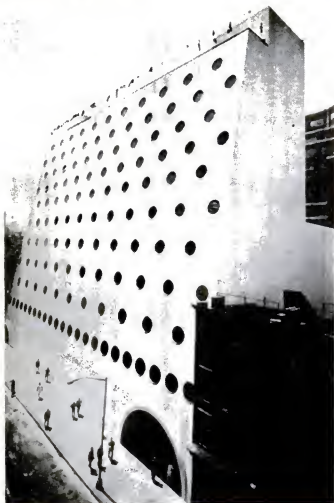
The thing to avoid is allowing the 'Cat to get in a position defying one or more basic laws of physics. True, it's a go-anywhere vehicle (makes a great snowmobile, by the way), but on its own terms, thank you. It *can* be tipped over, and it tends to fly like a rock if you try leaping off steep embankments.

DESPITE head and taillights, Amphicat is a true off-road rig. You can get an optional 20-hp version



I tried zooming off a sharp, three-foot drop into a pond, and, while the 'Cat is unsinkable, it entered the water as if completing a half gainer. Sitting there in a cockpit full of icy water gave me reason to know the 'Cat will cooperate fully . . . to a point.

Sold by Mobility Unlimited, of Auburn Heights, Mich., Amphicat's price is \$1295. That's a lot of money for an outdoors-y toy, but then again, the 'Cat is a lot of toy. ★★ ★



Salty school for sailors

The National Maritime Union training school in New York sports an unusual exterior. It has a rakish $8\frac{1}{2}^\circ$ inward slope (to conform to the city's "setback" law) and its windows are all "portholes," $5\frac{1}{2}$ feet in diameter.



Here's a shop project! (But, sorry, we don't have plans)

London's "queen of hardware" glitters regally, but she'll hardly set a fashion trend. Her aluminum crown sparkles with 346 wood screws, the heads of 55 others and six chrome-plated dome tops. Her cloak is aluminum foil and her gown, 403 mesh pan scrubbers.



Lots of muscle

The new 4000-hp, 130-mph Kestral, built by Hawker Siddeley, is the most powerful single-engined locomotive in the world.



Inside story in living color

German doctors can now study the inside of a human stomach in full color on a closed-circuit TV screen. A new Siemens camera, set up at the end of a fiber optic tube inserted in a patient's mouth, transmits the image.





Snow melters

Roof-heating panels are being installed on Japanese homes to keep ice and snow from building up along roof edges. The panels, which are sandwiches of cross-woven heating elements covered by sheet metal, were developed jointly by Matsushita Electric and Hokkaido Electric Power Co.



Pint-size hovercraft

Powered by a 3½-hp gasoline engine, the Mini-Hovercraft floats 3 inches above the ground and will travel 15 mph. The 6-foot-long, fiberglass craft weighs 73 pounds. Here, a model demonstrates how a rider operates the new British "supertoy." Another version of the hovercraft is 9 feet in length.



Room with a view

A pilothouse that moves up and down on hydraulic stilts solves some knotty navigation problems for the skipper of the towboat, *Mobil Leader*, which pushes strings of barges on the Mississippi River. With up to 15 huge barges strung out ahead, the pilothouse at its full height of 16 feet enables the man at the wheel to see over the lead barge. When a low bridge comes along, the pilothouse drops down to the deck. Automation of the boat allows bridge control of all engine room functions. Builder of the craft is Jeffboat, and the automation system was designed by Mobil's Marine Technical Div.

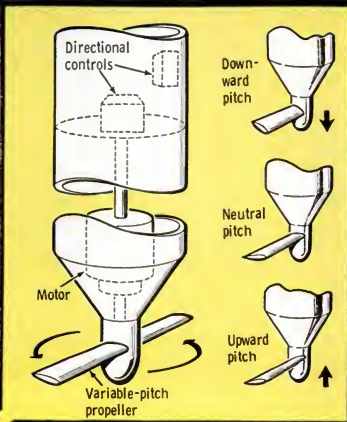


Just patented

PM'S PICK OF THE NEW INVENTIONS

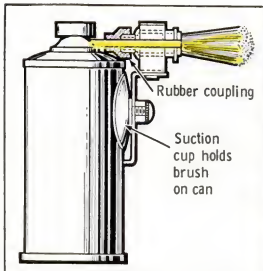
Prepared in cooperation with Roger S. Shashoua, Director, International Inventors Association, Inc.

Illustrations by Don Evans and Herb Mott



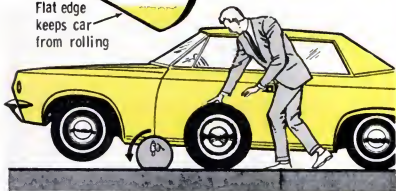
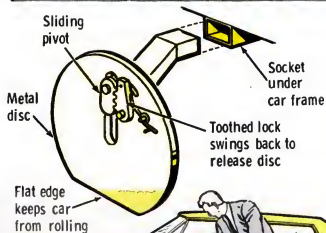
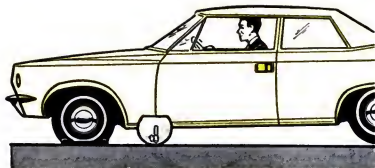
1. OFFSHORE OIL-DRILLING RIGS tend to tip in rough water and are sometimes in danger of capsizing. The floating platform shown here uses variable-pitch propellers at the lower ends of its legs to stabilize it automatically. As one corner tilts downward, its prop pushes upward, while props at the other corners pull downward to level the platform. The pitch controls are actuated by sensitive gyro mechanisms up on deck

2. CLIP-ON SHAVING BRUSH at right is designed for men who prefer to apply lather with a brush but who still would like the convenience of a spray-on cream. The brush attaches to a regular pushbutton dispenser and feeds premixed lather out through its bristles. A rubber coupling connects the spray nozzle to a hole in the brush, and a suction cup holds the accessory to the side of the can. When one dispenser is empty, you simply remove the brush and hook it onto a fresh supply of the cream

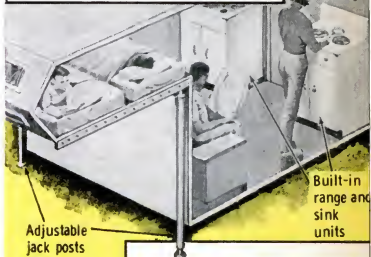
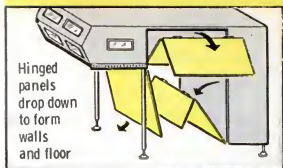


Inventors of the devices shown on these pages are as follows: 1. Sheldon B. Field, Floral Park, N. Y. (No. 3,349,740); 2. Clarence B. Johnson, San Bruno, Calif. (No. 3,346,908);

POPULAR MECHANICS



3. THERE'S NO CRANKING to jack up a car with the ingenious off-center disc above. You just slip the disc into a socket under the car's side and roll ahead. As the disc turns, its eccentric cam action automatically lifts the car off the ground. After the tire is changed, a lever releases the disc's pivot, lowering the car. To jack up a rear wheel, the car can be pushed by hand up and onto the disc



4. YOU DON'T NEED A TRUCK or trailer to tote a family camper. The piggyback rig above fits over the rear end of an ordinary sedan and adds only two feet to the car's length. At the campsite, it is detached and panels drop down to form walls and a floor. There's a bunk space for kids up front, and cats fold out below for Mom and Dad. Range, sink and other utilities are built into the rear wall

5. THIS COLLAPSIBLE STOOL folds up into such a compact package it can be carried like a lady's handbag (left, below). Telescoping metal tubes hidden inside (center) slip quickly into sockets to give the seat tripod legs capable of supporting up to 300 pounds. The portable stool is designed for campers, sparsmen, travelers and others who want a temporary seat without the bother of carrying a heavy, bulky chair



3. Michael Rossnan, Silver Spring, Md. (No. 3,348,807); 4. John V. Henson, Baltimore, Md. (No. 3,337,259); 5. Westerwalder Kunststoffwerk, Altkirchen, West Germany.

BUILD YOURSELF THIS

One-Man Sports Submarine

In an exciting new scuba sub, instead of wearing a mask, you ride with head and shoulders in a dry conning tower

By KEVIN V. BROWN

IF YOU HAVE a slight case of claustrophobia, as I do, the hardest part is just climbing into the thing. The rest is easy.

I took a few deep breaths—and chickened out each time—then growled, “Aw, come on, let’s get it over with.”

I ducked down, holding my nose, slid my head and shoulders sideways, then pushed up beneath the plastic dome. My head came up above the water line, I opened my eyes, released my nose, and exhaled luxuriously. “How about that! It works.”

The air hose was draped over the steering post, and I pushed the button on the mouthpiece a few times, comforted by the “hiss-hiss” of new air.

Kent Markham, standing by the craft on a shallow bank, grinned. “Okay?” he asked, but his voice was faint and hollow in my watered-in chamber.

He leaned closer. “Let’s push off.”

I sat firmly on the battery case, then with my feet outside the ballast tray “walked” into deeper water. Soon I was floating, with just the dome above the water line on the outside, and my head, shoulders and part of my chest above it inside.

The dome began to fog up from my breathing, but the view downward was sheer beauty. I was at Silver Springs, Fla., floating in perhaps the clearest water anywhere on this earth, and I was riding in Markham’s new one-man home-built submarine. A math



AUTHOR prepares for voyage to bottom of Silver Springs, assisted by designer Kent Markham (right) and Springs photographer. Delta-winged submarine can go to bottom of lakes or rivers, while domed chamber keeps diver’s head dry. At right, sub rests amidst waving seaweed on floor of Silver Springs

teacher at John Gorrie Junior High School in Jacksonville, Fla., he designed and built it in his spare time, and had plans printed so anyone else could build one, too.

He calls it a semi-dry submarine, because the upper part of your body is out of the water at any depth and you are breathing freely without wearing a mouthpiece or mask, although you can wear either if you choose. It’s a vehicle sportsmen—or even serious divers—might enjoy using.

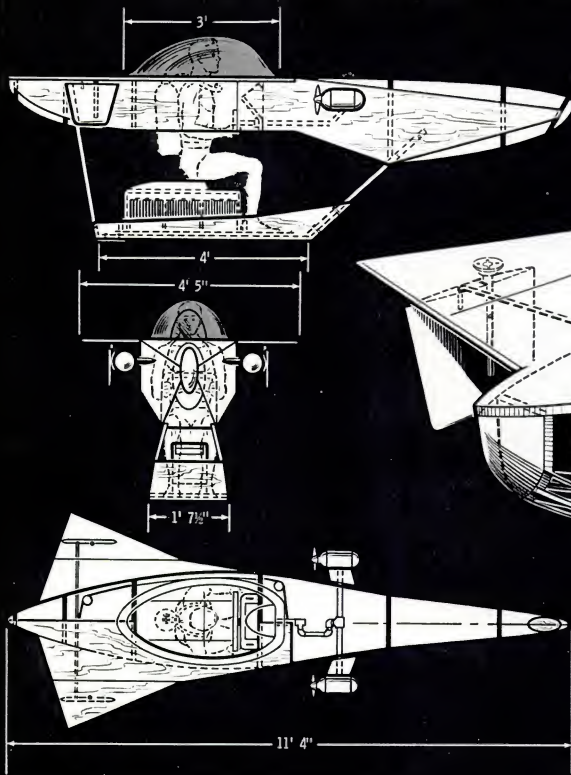
When I had floated away from the bank, I began experimenting with the “constant buoyancy valve,” a simple length of pipe with a “V-slit” at the open end and attached to a free-swinging elbow joint at the other end. The joint opens to the outside of the chamber, and is one of the keys to Markham’s design.

The pipe pointed almost straight

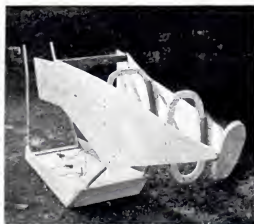
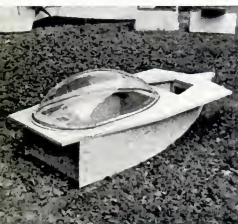
(For cutaway drawings and construction pictures, turn the page. *Text continues on page 192*)

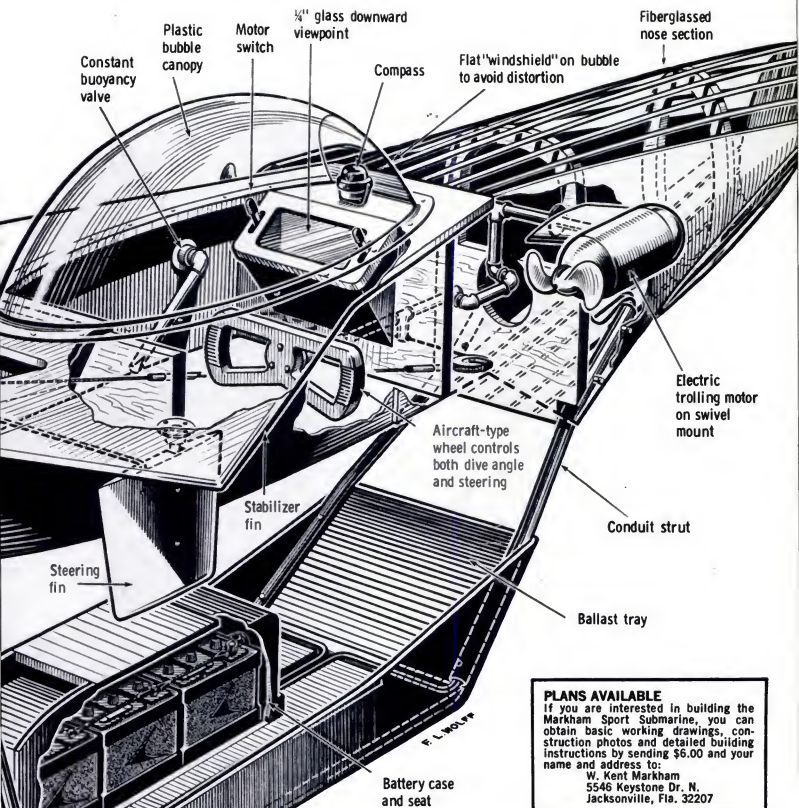


MARKHAM SPORT SUBMARINE



SPORT SUBMARINE, shown in art cutaway and photos, is basically plywood construction with metal tubing. Plastic bubble is vital. Sealed with copper tubing, it contains air pocket

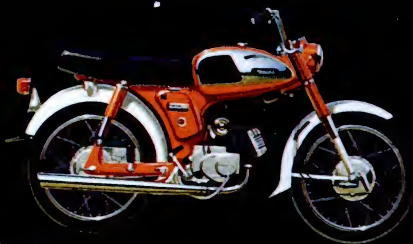




BOLTS AND SCREWS and some marine glue hold sub together. Tapered nose is shaped with thin ribs then covered with fiberglass. Bright paint covers all



A Beginner's Guide



BANTAMWEIGHTS are ideal motorcycle runabouts, offering adequate power, maximum maneuverability, good economy



LIGHTWEIGHTS afford all-round motorcycling fun, are fine for back-and-forth-to-work-commuting, cross-country "larking"



TRAIL BIKES feature upswept exhaust system to clear off-road obstacles. Big-bite knobby tires provide Go in rough terrain

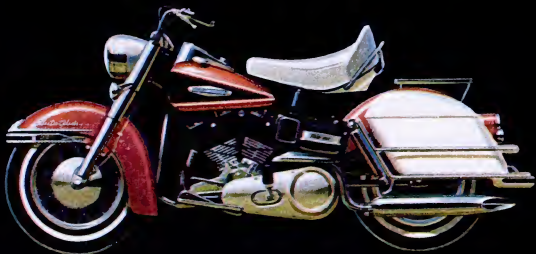
to Motorcycles



MIDDLEWEIGHTS offer ideal combination of comparatively low initial cost, high performance, agility, economy of operation



HIGH-TUNED HEAVYWEIGHTS, usually with dual carburetion, stress high performance, agility, make outstanding tourers



BIG HEAVYWEIGHTS offer maximum comfort for long distance touring. Engine displacements near those of smaller cars

Turn page, please ▶

PM GUIDE TO LEADING MOTORCYCLES*

MAKE	MODEL	TYPE	ENGINE		PERFORMANCE		TRANSMISSION	WEIGHT Lbs. (Approx.)	PRICE NEW (Approx.)
			CC	Cycles	0-60 (Secs.)	Top MPH			
HEAVYWEIGHTS—Over 500-cc Piston Displacement									
Harley-Davidson (U.S.A.)	Electra-Glide	Street	1200	4	5.7	98	4	783	\$2100
Harley-Davidson (U.S.A.)	Starliner	Street	900	4	6.2	112	4	545	1835
Norton (U.K.)	Scrambler	Street/Scrambler	750	4	6.2	102	4	368	1400
Norton (U.K.)	V-7	Street	700	4	7.7	102	4	715	1435
Benelli (Italy)	Spitfire Mark 3	Street	650	4	5.4	117	4	415	1460
BSA (U.K.)	Commander	Street	650	4	5.3	112	4	450	1300
Kawasaki (Japan)	R-60	Street	600	4	7.8	88	4	440	1420
BMW (West Germany)									
MIDDLEWEIGHTS—300 to 500-cc Piston Displacement									
Suzuki (Japan)	500/5	Street	500	2	5.2	108	5	385	\$1035
Triumph (U.K.)	T100R	Street	500	4	7.0	105	4	365	1200
BSA (U.K.)	Shooting Star	Street	441	4	NA	NA	4	325	950
Bridgestone (Japan)	GTR	Street	350	2	6.7	104	6	362	900
Jawa (Czechoslovakia)	Californian	Street	350	2	10.0	76	4	300	595
Kawasaki (Japan)	Avenge	Street	350	2	6.1	104	4	320	815
Honda (Japan)	CL350	Street/Scrambler	350	4	NA	100	5	340	700
Yamaha (Japan)	YM1	Street	305	4	13.7	100	5	350	700
LIGHTWEIGHTS—125 to 300-cc Piston Displacement									
Mojave (Italy, for Wards)	260	Street	260	4	8.0	80	4	290	\$715
BSA (U.K.)	Starfire	Street	250	4	18.2	86	4	300	750
Benelli (Italy)	Barracuda	Street/Scrambler	250	4	13.5	82	4	245	650
Bultaco (Spain)	Matador	Street/Scrambler	250	2	NA	NA	4	235	775
Suzuki (Japan)	X-6 Husler	Street	250	2	NA	95	6	290	735
Yamaha (Japan)	YDS-5	Street	250	2	11.4	88	5	340	655
Montesa (Spain)	Scorpion	Street/Scrambler	250	2	18.7	75	4	235	750
Ossa (Spain)	Pioneer	Street/Scrambler	250	2	NA	NA	4	230	730
Bridgestone (Japan)	175	Street/Scrambler	175	2	NA	NA	5	275	650
Riverside (Italy, for Wards)	175	Street/Scrambler	175	2	NA	NA	4	220	475
Ducati (Italy)	Manza Jr.	Street	160	4	17.1	NA	4	240	530
Honda (Japan)	CL160	Street/Scrambler	160	4	17.1	75	4	270	610
Harley-Davidson (U.S.A.)	Rapido	Street	125	2	NA	65	4	175	425
BANTAMWEIGHTS—80 to 120-cc Piston Displacement									
Kawasaki (Japan)	Road Runner	Street/Scrambler	120	2	NA	NA	4	185	\$420
Bultaco (Spain)	Lobita	Street/Scrambler	100	2	NA	NA	4	175	445
Suzuki (Japan)	AS100	Street/Scrambler	100	2	NA	NA	4	175	380
Yamaha (Japan)	YL2C	Street/Scrambler	100	2	NA	NA	4	220	390
Hedaka (Japan)	Ace 100	Street/Scrambler	100	2	NA	NA	4	180	425
Honda (Japan)	90	Street/Scrambler	90	4	NA	NA	3	180	395

NA—Not available

*Not all makes or complete model lines are represented in this guide

Buying Your First Motorcycle

Price and intended use are the main considerations, but it makes sense to start small and learn all the ropes

By DOUG RICHMOND

BUYING A MOTORCYCLE a few years ago was a fairly simple task. As a buyer, you had your choice of a big Harley or Indian, new or used. That was it. Period.

But today you are offered something like 30 different brands, a full range of sizes from little tiddlers up to huge German Mammoths and American Harley-Davidson Duo-Glides with engines as large as some sports cars.

Because most motorcycles sold today are special-purpose designs, if you're a first-time buyer you must decide what you're going to do with a bike. A big, fast machine designed to stick to pavement may prove an abomination on fire roads, or "cow trails."

The most important single consideration in the selection of a motorcycle is size, and in motorcycles the piston displacement of the engine expressed in cubic centimeters—cc for short—determines the size.

If you are primarily interested in speed, with good road-holding ability on pavement, the more highly tuned heavyweights are your best bet. The English 750-cc Nortons and Royal Enfields, the twin-carburetor BSAs and Triumphs of 650-cc displacement, the 500-cc Velocette Thruxton, the German BMW R-69 and Harley's 883-cc Sportster fall into this classification. These machines accelerate like a dragster and are often so powerful that suddenly opening the throttle in first or second—and sometimes third—will, by sheer power, lift the front wheel.

And it is for just this reason that a first-time, inexperienced motorcycle-buyer should leave them strictly alone. A slight mishandling of the controls—something that might pass unnoticed

on a smaller, less powerful machine—could send one of these bikes crashing into an intersection, or flip it over.

If you intend to do much long-distance touring, the larger detuned models from the same makers are for you. The big Harley 1200-cc Electra-Glide, with its soft suspension and huge engine that just loafs at 70 mph, is great for touring, as are the single-carburetor BSA and Triumph 650s. The 600-cc BMW R-60, with its shaft drive, magneto ignition and completely separate lighting system is another old tourer standby. Italy offers the 700-cc Moto-Guzzi, and from Japan comes the 650-cc Kawasaki.

These bikes tend to substitute reliability and lack of tinkering for pure speed, and sacrifice a certain degree of road-holding—which generally requires stiff suspension—for comfort. But they can be ridden hour-in-and-hour-out with as much comfort as is possible on a motorcycle. Most long distance touring is done between 50 and 70 mph (with more at the lower figure than the higher), and these touring bikes will do such speeds easily and with an absolute minimum of fuss and bother. Also, they're just the ticket if you ride to work on open highways.

The middleweights, with engines from 300 to 500 cc, are something of a compromise. They are on the average quite a bit lower in price than the heavyweights and may go almost as fast. They have more than enough power to be practical for touring, and are not so large as to be unwieldy in traffic. In this range the two-cycle engines first come into consideration.

The argument over two- or four-cycle

(Please turn to page 180)

Amazing Man-Made Gems—



ONE OF THE STAR RUBIES above is genuine and one is synthetic. Can you tell which is which? Here's a hint: The man-made stone looks more perfect than the natural one. The same holds true for the pair of star sapphires at left—one came out of the ground, the other out of a laboratory, yet they're so identical that only experts can tell them apart. (In the rubies, it's the one on the left that's synthetic; with the sapphires, it's the one on the right. Note in each case how the highlights creating the star effect are more pronounced in the synthetic jewel—the

only tip-off.) Proof that lab-created gems are not necessarily cheap is the matched set of gold and ruby cuff links and tie clip below valued at several hundred dollars. The lucky lady at left below is getting a sapphire pendant that would please a queen, synthetic or not. Gems shown are produced by the Linde Div. of Union Carbide



Synthetic rubies, sapphires and emeralds, chemically identical to natural stones, are so perfect it's the only way you can tell them apart—they're too perfect to be genuine.

By ARTHUR S. FREESE

They're Real, Not Fakes

FOR THOUSANDS OF YEARS, rubies, sapphires and emeralds have been among man's rarest and most highly prized treasures. Now we can produce these glittering jewels in a factory. The amazing thing about modern man-made gems is that they aren't just imitations of the real thing—they *are* the real thing. They are as identical to natural stones as an ice cube frozen in your refrigerator is to an icicle created on a cold day outdoors. The only difference is that one is produced by nature and the other is produced by machine.

Today, every one of us owns some of these jewels—in a watch, radio, phonograph needle, even as the tip in a ballpoint pen. Produced inexpensively, they take wear and abuse no metal could withstand. In purer forms, they have made possible space-age technology, solid-state electronics and the fantastic world of lasers.

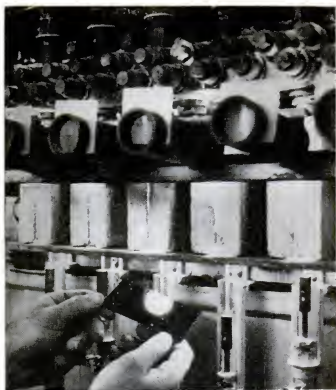
Beautifully cut and polished synthetic stones, like the sparkling star rubies and sapphires shown on the opposite page, are also revolutionizing the jewelry business. While they are not necessarily cheap, they cost substantially less than their natural counterparts. In sizes ranging from one to three carats—typical for many pieces of jewelry—they may sell for as little as \$15 to \$25 a carat, compared to as much as a \$1000 a carat for an identical, mined stone.

These man-made jewels are exactly the same as genuine stones in chemical composition, atomic arrangement and optical properties. In fact, they're even better. Because they're created under precisely controlled laboratory conditions, they can be made near-perfect. One of the few ways an expert can tell them apart is that they're more perfect than nature herself can produce. Mined gems always have defects.

Almost all gems are minerals with a definite crystal form—inorganic substances whose atoms are arranged in an orderly latticework. There are some 1600 mineral species in nature,

FIERY BLOB at right above, known as a "boule," is a jewel in the making. Inside a Verneuil furnace, it grows little by little as molten particles of aluminum oxide fuse to it under intense 2200° C. (3960° F.) heat of a hydrogen-oxygen flame

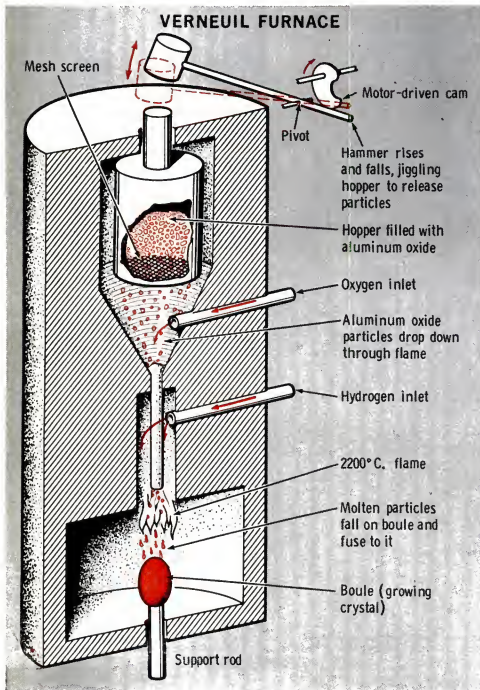




but only 80 are considered as gems. The more important of these are now synthesized—ruby, sapphire, quartz, diamond and spinel, the last being a hard mineral found in various colors in its natural form. Strictly speaking, quartz is not classed as a gem, but is grouped with them because it performs many of the same functions.

The most important property of these stones is their hardness. On the Mohs hardness scale, diamond, hardest of all substances, is listed as 10. Ruby and sapphire are rated right behind it at 9. Spinel is 8, and quartz 7 (the dividing line between hard and soft gems).

The first synthetic gem was made in 1880 in Glasgow, Scotland. James Balantine Hannay, a chemist, mixed par-



HOW A JEWEL IS "GROWN" is shown in the diagram at left of a Verneuil furnace. The boule, or growing mineral crystal, is supported on a rod in a fireproof chamber at the bottom of the furnace. Above it, oxygen and hydrogen are mixed to produce a 2200° C. flame like a blowtorch. Particles of aluminum oxide are melted as they fall down through the flame and fuse to the boule, causing it to grow bigger. A clever hammer device, actuated by a motor-driven cam, keeps tapping the aluminum oxide container at the top of the furnace so the particles fall out the bottom through a screen. When the boule has grown to desired size, it is removed and allowed to cool slowly. The photo at the upper left shows a row of gem-fusing furnaces being checked by a technician. A mirror lets him see up into the bottom of each furnace to tell how the boule is growing



SYNTHETIC RUBY CRYSTAL, the tiny cube at center above, is the heart of this laser setup at Hughes

The average boule is about the size of your thumb and takes three or four hours to grow. The Verneuil furnace is actually a vertical hydrogen-oxygen blowtorch producing a flame of 2100° to 2200° centigrade (3780° to 3960°F.)—hot enough to melt aluminum oxide particles as they fall through the flame and fuse to the growing boule. It is estimated that of every 100 carats grown, only two carats represent valuable gems. The rest are of lower quality for industrial use.

A woman would find it hard to believe that her red ruby and blue sapphire are actually the same, but they are. Sapphire and ruby are two differently colored varieties of the same transparent mineral, corundum. Chemically, they are alumina—aluminum oxide—and only impurities cause the



FIVE STAGES from rough boule to finished jewel are shown above. Each boule is sliced into discs (center photo), which are then ground to a dome shape. A final polishing (far right) brings out star highlights

affin, bone oil and lithium and heated them red hot in an iron bomb he had welded shut. After 14 hours, he took out some tiny stones and deposited them with the British Museum of Natural History in London. There they lay until 1943 when an X-ray examination proved they were diamonds. No one has ever been able to duplicate Hanay's process.

It was in 1902 that the synthetic gem industry was founded by a French chemist, Auguste Victor Louis Verneuil. He developed the flame-fusion process for synthesizing corundum and spinel. His method is still the most widely used, and the furnaces are named after him. His synthesis is called "growing a boule." Boule is the French word for ball.

coloration. The red of the ruby is due to a trace of chromium oxide; the blue of the sapphire to traces of iron, titanium or cobalt oxides.

An industrial scientist recently showed me what looked like a solid red glass rod nine inches long and an inch in diameter. It was as heavy as a lead pipe. Holding it to my eye like a telescope, I could see through the nine inches as if the rod were only a thin, flawless piece of red glass—so perfectly did the light pass through its length.

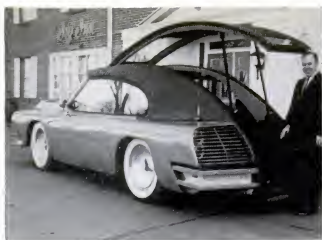
This was a ruby laser, worth some \$5000. The same weight in natural rubies (you couldn't get one this size) would be valued at a minimum of \$500,000. As the scientist put it: "Anything good enough to modulate a laser

(Please turn to page 188)



Paralyzed parkers

Drivers who leave their cars illegally parked in Paris now return to find their front wheels secured by a giant lock. A trip to the police station and a 50-franc fine unlock it.



Use the rear entrance

A rear door that eliminates side doors and knobs is one of the many safety and luxury features of the Mohs Ostentatienne Opera Sedan. The car sells for \$19,600.



Dutch aim for moon ride

Dutch scientists have come up with their own version of a car suitable for use on the moon. It features giant tires, sealed engine and body and two large oxygen tanks.



For a circle of friends

People who like to sit around together will take to this Danish-designed sofa. Called the Crown settee, the round sofa sells for a little over \$1100.



London transit trains to operate automatically

It'll be a hands-off operation this fall when London Transport's automatic trains go into operation on one branch of the transit line. Once the doors are closed and the start button pressed, the trains operate automatically, responding to coded impulses sent through the track.





The big picture

Tourists at the visitor center overlooking Arizona's Glen Canyon Dam (right) can also view a 20-foot-long relief map of the 15,360-square-mile upriver area that drains into the Colorado River. Shown at work on the plastic-foam map is Robert Miller.



British architects design a city in the sea

A city of 30,000 people could be located 15 miles off the east coast of England, according to a group of British architects. The project, called Sea City, could add new living area for a growing population. Surrounded by a 180-foot-high wall, the city would be supported by piles and concrete pontoons. The main industry would be fish farming.



HOW TO MAKE BIG PANORAMAS FROM

When you want to capture a beautiful view that's too wide for your camera lens, just shoot it in several parts and piece them together. With this easy hand-held method, you don't even need to use a tripod

HOW WOULD YOU LIKE to make a photograph two or three feet wide capturing the sweeping grandeur of a mountain view, a shimmering seascape or a far-flung city skyline? Such scenes are too big to put on one piece of film. But you can put them on several pieces of film and join the pictures side by side.

Shooting panoramas is often considered a job for a pro, but it's actually a simple process. If you can take one picture, you can take three in a row. I once made a panorama covering 360° and involving 15 separate views—all shot with the camera hand-held. The only thing you need to be sure of is that the segments will join together properly to form a continuous picture. Since you can't judge exactly where

one scene will end and the next one begin, you deliberately overlap your segments slightly, then trim them later. The drawing on the opposite page shows how you can use a tree, pole, building or other identifying object to help guide you in matching scenes.

As you swing the camera to take in different views, pivot your body from the waist up without moving your feet. This

MATERIALS FOR SPLICING are simple—some tape and a razor knife. A paper cutter is handy but not essential. Three prints shown here are those from which the panorama at the top of the page was made





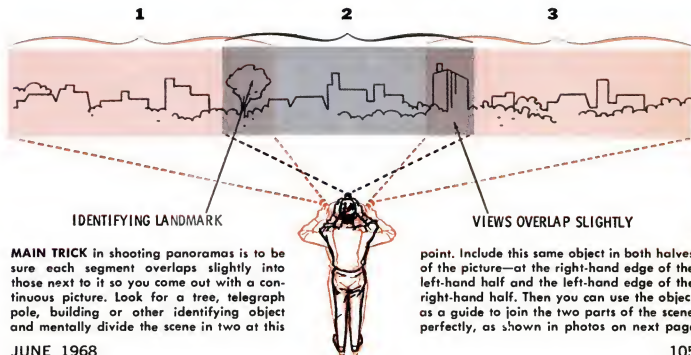
SWEEPING VIEW of Fort Worth, Tex., skyline, not possible with a normal lens, was made by shifting camera to take three separate views and then piecing them together

LITTLE PICTURES By GORDON SMITH

will keep the camera in the same relative position and minimize distortion. Try to hold the camera at the same level for each view, but don't worry if the alignment isn't perfect. Slight mismatches between views are simply trimmed off later. As a rule of thumb, locate the horizon line about a third of the way down from the top of the viewfinder and this will automatically keep the views aligned. If there

is no horizon, use your identifying object to guide your positioning.

Wherever possible, make all shots at the same exposure. Minor differences in negative density can be adjusted in printing to keep the background areas close in tone so the seams won't show. On the following page are step-by-step photos showing how to trim and splice the prints to form a single panoramic picture. ★★★





SPRAWLING GOLF COURSE PANORAMA was shot in two parts, requiring only a single splice at the center



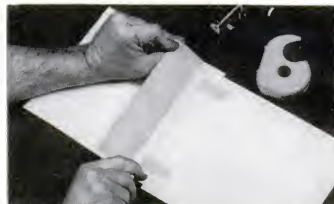
1. FIRST STEP is to trim the side edge off one print. Make this cut through or near your identifying object. Now slide the trimmed edge over the adjacent print until you have a match. At this point, cut a small slit at the top and bottom of the second print, using the trimmed edge as a guide. Keep the horizon straight



2. TRIM THE SECOND PRINT on a paper cutter, using the slit marks at the top and bottom to line it up. This will give you a perfect match with the trimmed edge on the first print. If no paper cutter is available, lay a steel straightedge over the print at the slit marks and run a knife along it to trim off excess



3. STICK SMALL TABS of tape to the back of one print so the ends protrude slightly. Let these tabs slide over the adjacent print while you're adjusting the alignment. When the match is perfect, lift the corners of the second print so the tabs slip underneath, then press firmly down on the tape



4. AFTER THE PRINTS have been temporarily joined with the tabs of tape, reinforce the seam with a strip of wide paper tape. This can be the brown gummed kind used in stores to seal packages, or you can cut a strip of stiff regular paper and fasten it with print-mounting cement (not rubber cement)



5. JOINED AT THE SIDES, prints are now ready for trimming at top and bottom. Note that views do not have to be shot at exactly the same level. Discrepancy shown here was deliberately exaggerated to show that effect isn't harmful. Normal hand holding results in only slight differences in camera level



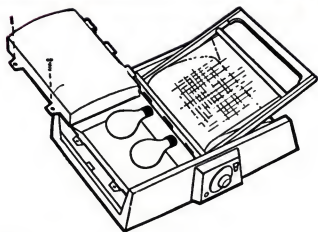
6. FINAL TRIMMING eliminates ragged edges at the top and bottom and gives the appearance of a single photograph. Be careful in trimming to keep the horizon level. Lay a straightedge across the top of the picture and measure up from the horizon line at each end to be sure that trim line is parallel

NEW IN

PHOTOGRAPHY



POLAROID'S POPULAR SWINGER now has a big brother—the "Big Swinger." The new instant-print camera takes larger pictures than its predecessor, using a $3\frac{1}{4} \times 4\frac{1}{4}$ -in. film pack. Yet it's actually 4 ounces lighter, weighing only 17 ounces. It incorporates the same "yes" indicator for proper light as well as built-in flash. A new swiveling T-handle (right, above) makes tabulating easier. You just let the camera hang and pull in any direction instead of having to hold it level. Price is \$24.95



JUST DIAL ANY SLIDE you want in the circular tray above and the "Slide Seeker" will find it for you automatically and project it on the screen. The Slide Seeker fits on top of the machine and is designed as an accessory for a new line of Ansco camera projectors made by General Aniline & Film Corp., 140 W. 51st St., New York, N. Y. 10020. The slide finder sells for \$40, the projectors for about \$155 to \$200 in three types of models

FIRST COPYING MACHINE for home use is the 8-pound portable Copymate at left above. Priced at \$29.95, it's designed for copying family documents, household business records and research for school work. Special paper is exposed over a lightbox (left). Then it's developed over a heated pad where warmth brings out the image. The process takes less than a minute, makes copies up to 8×10 in. Graphic Products, Inc., 200 Fifth Ave., New York, N. Y. 10010



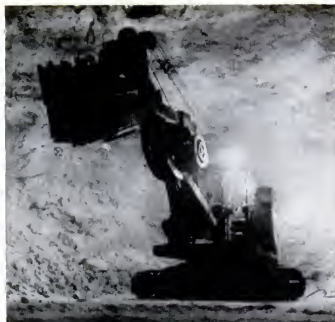
Atomic coat of arms

The German town of Grobvelzheim likes its nuclear power plant so much its crest sports an atomic sign under crossed swords.



A warming ceremony

When a bride and groom kneel on this prayer bench, they may be nervous, but they're not cold. A heater hidden inside is designed to take the chill off a drafty church. It's being tried in the French town of Lille.



World's most stable lab

Engineers looking for a stable place to test delicate spacecraft gear found the perfect spot—1130 feet underground in a Detroit salt mine (top). The dense salt damps out vibrations that could throw a rocket guidance system out of whack. Inside the mine, the LTV Aerospace Corp.'s lab (center) houses test instruments (bottom) in shock mounts.



Outboard power for Vietnamese vegetable growers

American outboard motors, converted into irrigation pumps by reversing the propellers and encasing long shafts in metal tubes, are making possible a highly successful vegetable-growing industry in Vietnam. The unusual use of the 4.5-hp motors was discovered by a Vietnamese farmer. They're being imported through the Agency for International Development.



Sweet Chariot swings low to rescue downed airmen

As many as three downed airmen can be lifted at one time on Kaman's Sweet Chariot rescue seat that's used by rescue helicopters in Southeast Asia. The seat folds to a cylindrical profile so it can be lowered through trees. When it reaches the person being rescued, he lowers one of three spring-loaded seats, straps himself on and is hoisted to safety.

PM OWNERS REPORT: AMERICAN MOTORS JAVELIN

WHATEVER YOU DO, don't ask a man how he likes his new Javelin—not if you're in a hurry. The boundless enthusiasm of most owners could pin you against the men's room wall for half an hour; the grief of a garrulous few could sour that one-quick-beer and have you crying by the sixth.

We found this out when an innocent-looking, routine bag of mail arrived at PM. What poured out of that bag was an unprecedented deluge of prompt replies to an owners survey.

Not content just to answer the ques-

cars of all makes and I guess I can speak with some authority. I'll say one thing: Rambler has come a long way, and I can honestly say this is the most pleasing car for handling, looks and power that I've ever had. I can't say enough good things for it."

A California teacher observes, "I always wanted a Rambler that didn't look like a box." And a test technician in the same state says, "I've always liked American Motors quality but not the box shape of their cars; they've finally gone modern."

Some of these owners have been in the AMC cheering section for a long time. Others, like a 19-year-old California ma-



GREAT HANDLING say owners, many of whom compare it to other sporty cars they've owned or driven

tions in the space provided. Javelin owners, anxious to tell us about flying around in their "Jaybirds" for a total one and a half million miles, wrote up, down and around the page. Often they added a few strong-worded—most good, some bad, but none indifferent—pages of their own. One thing's for sure: There's not an owner who's wishy-washy about his car.

Pinning the applause meter is lots of noise about style. For an Illinois salesman, a good-Samaritan trip was a rendezvous with destiny: "I drove my brother-in-law to the dealer to pick up his new Rebel and I ended up buying a Javelin."

A California postal carrier swoons, "I fell in love with the shape of the car, same as I would a blonde." An Alabama architect proclaims: "excellent design." A New Jersey insurance consultant, still amazed, says, "Before I bought the fantastic Javelin, if anyone told me I would own a Rambler, I would send the men in white coats after him."

While the white coats are still in the area, here's a California landing gear inspector who says, "You'll probably think I'm a crackpot. But I've had 29 new

Photo Finish for Owners Balk at

By BILL HARTFORD, Associate Auto Editor



chinist's apprentice, are newcomers who are finding AMC makes what they want: "Styling, handling, go!, braking and comfort all rate No. 1. And next time around it'll be the AMX."

A young Missouri architectural designer effuses: "swinging design." An older missus, a Minnesota hotel manager, feels a little self-conscious: "I really don't have any complaints, but I sometimes think it is a little sporty for an old woman!"

As to why they bought the Javelin, some owners—unhappy with the proverbial this, that, or the other thing—blast out like this Arkansas salesman: "Why did I buy a Javelin? I wish I knew"; or this Georgia machinist, "Because I was a sucker," or this Illinois pipe fitter, "You

just can't judge a book by its cover."

An Illinois truck driver and a California longshoreman have two different attitudes regarding their bitter purchase. Wails the former, "I got took but good, and I don't care who knows it. I am very disgusted." The latter confides, "To be truthful, I have no praise of the car. But when my friends ask, then I really boast about it to cover up my goof."

A Las Vegas casino dealer tells us about his personal racing history: "This car is a handler, finest production car in the U.S. I get some acceleration with the 343! I've raced it against 400 GTOs, 396 Chevilles, 289 and 390 Mustangs and 327 and 350

Style and Handling; Tricky Windows

Photos by Irving Dolin



WINDOW ACTION could be better. For some owners window rattles when half open, isn't snug when up

Camaros, and it is unbeaten so far. In respect to my 12 mpg around town and 16 mpg on the highway, I believe it would be much better if I kept my foot out of the carb."

A California station installer owns a Javelin, and he's not one for paper tigers: "It's a beautiful machine. It's great in cornering speed, power, etc. It's nice looking but, believe me, there's no grass growing under the tires. We *drive* it—we don't baby it."

Even tamer owners like this Florida serviceman with a 232 Six engine, wave the checkered flag for their Javelin: "The six-cylinder engine has lots of power and great economy . . . handles better than the XKE Jag."

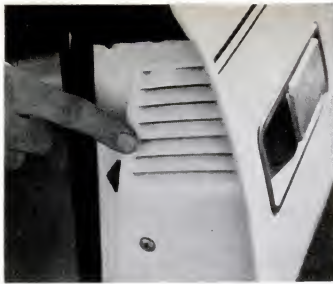
A New Jersey mechanic begs to differ. Determined to run a supercar, he can't do it with his modest 290: "How about some tips on how to get some performance out of this stone?"

With the hot competition in the sporty car class, Javelin owners made sure they saw and drove them all. A California teacher says, "You name it, I drove it."

A comparison test made by a California



TRUNK OPENING is too small and the trunk itself should be larger, say owners who need more space



FLOW-THROUGH VENT SYSTEM, inadequate for some owners, exhausts air through vents on the door edge

factory worker (one-fourth of replies were from California) reveals, "the Javelin will take the speed and hold the road much better than the '67 Camaro or '65 Mustang and I've owned both these cars."

The California machinist's apprentice, who mentioned that he's already eyeing the AMX, *really* has an affection for his new Javelin. He says of his accident: "I climbed an embankment and flipped over endwise. When the car came to rest, my passenger and I were hanging upside-down by the seat belts—unhurt. I can safely assure anyone that AMC builds extremely strong and SAFE cars. The top wasn't even pushed in an inch."

The Javelin isn't without its share of troublemakers. The one-piece side window is one, the flow-through vent system that replaces the vent pane is another. As a California barber says, "I like the windows for looks, liked the vents for convenience." And a California school administrator threatens: "The flow-thru system

is grim, I may have to give up smoking!"

► **Good.**

A Florida technician complains, "There's no exhaust from the interior. Vent under armrest and out door edge isn't sufficient. What's AMC going to do?"

► **Vents will be the same next year.**

The side windows themselves give some owners trouble for several reasons. Rollup is tough. A California fireman's wife suggests power windows: "The additional glass weight or window construction seems to make glass roll a mite hard."

Other complaints include "vibration of door windows when they're partly open." "Windows don't roll up right" and "car isn't airtight" are further criticisms.

► **There'll be no power-window option in 1969, but AMC says windows on current production models work easier and shut tighter.**

Among the workmanship complaints, mostly about specific instances of assembly-line goofs, were several general re-

SEMI-FASTBACK ROOFLINE and rake of windshield posts is American Motors styling coup; owners confirm it





COMFORT RATING for front seat is good; rear seat hard to get into but roomy for size of the car

marks: "too much plastic-type material"—Maryland electrician, and "Everything inside seems to be made of plastic!"—California stenographer.

► **Do you know the grille is plastic, too?**

Plastics isn't a five-and-dime technology anymore (if it ever was). You'll be seeing

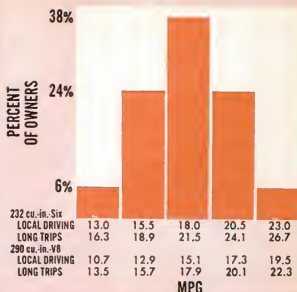
MOST POPULAR ENGINES are 232 six and 290 V8. New 390-cu.-in. V8 is now available in the Javelin SST

more and more plastic—if you even recognize it as such. Remember, it has many advantages. And, incidentally, AMC gets the credit for the first industry use of fiberglass safety padding. It's "plastic" and it's on the Javelin windshield posts.

► **Don't knock it.**

★★★

AMC JAVELIN FUEL MILEAGE CHART



Summary of 1968 Javelin Owners Reports

Total miles driven 1,424,146

Average miles per gallon:

232-cu.-in. Six, local driving.....18.0

232-cu.-in. Six, long trips.....21.5

290-cu.-in. V8, local driving.....15.1

290-cu.-in. V8, long trips.....17.9

343-cu.-in. V8, local driving.....12.9

343-cu.-in. V8, long trips.....16.4

Specific likes:

Style 69.6%

Handling 61.2

Economy 30.8

Power 29.6

Comfort 26.6

Performance 20.2

Roadability 19.8

Ride 18.1

Room 8.4

Visibility 6.3

Brakes 5.5

Specific dislikes:

Window fit/action 19.5%

Workmanship 18.0

Wind noise 18.0

Vent system 9.3

Want bigger trunk 8.8

Plastic door locks 7.8

Dealer service 7.3

Roadability 6.8

Quality of interior materials 6.8

Rear visibility 6.3

Dash styling 5.9

Gas mileage 4.9

Mud is thrown up 4.9

Brakes 4.9

What changes would you like?

Better workmanship 10.0%

Rear ashtrays added 8.7

Bigger trunk 8.7

Restore vent window 8.2

Dash styling 6.7

Remove idiot lights 5.8

Reduce wind noise 5.3

Change vent system 5.3

Plastic door locks 4.8

Engine:

232-cu.-in. Six 41.9%

290-cu.-in. V8 41.5

343-cu.-in. V8 16.7

Transmission:

3-speed manual 18.0%

4-speed manual 11.0

Automatic 71.0

Had any mechanical trouble?

Yes 54.8%

No 45.2

What kind of trouble?

Carburetor (Includes routine adjustment) 29.4%

Door locks 14.9

Window action 16.2

Transmission 9.6

Electrical 8.8

Clutch 5.9

Dealer repair satisfactory?

Yes 59.7%

No 34.7

Why the Javelin?

Style 76.2%

Price 29.3

Past experience 12.6

Different 9.2

Handling 8.8

Performance 7.9

Reputation 7.9

Size 6.3

Is the Javelin your only car?

No 50.4%

Yes 49.6

Other cars owned:

Rambler, Rebel 36.0%

Chevrolet 16.0

Ford 9.6

Volkswagen 9.6

Corvair 8.0

Buick 6.4

Pontiac 6.4

Plymouth 4.0

What options/accessories?

Radio 75.7%

Power steering 49.8

Power brakes 24.0

Whitewall tires 19.5

Courtesy lights 13.3

Disc brakes 9.5

Handling package 9.5

Wheel covers 9.5

Airconditioning 8.6

Tinted windshield 8.6

Tilt steering wheel 8.1

Vinyl floor 8.1

Heavy-duty suspension 7.6

Positraction 6.7

Dual exhausts 5.2

Age distribution of owners:

15-19 48.3%

30-49 36.4

50 plus 15.3

*Where applicable percentages may not equal 100 percent due to rounding and/or insufficient sample.

For quick-on-the-draw USE A

All engines have at least one vacuum port^{*} where you can connect a vacuum gauge. It's an indispensable tool costing less than \$10



A SIMPLE VACUUM GAUGE can quickly detect a multitude of engine ailments, including bad valves, leaky head gasket, restricted exhaust, leaky intake manifold, faulty carburetor adjustment and improper valve and ignition timing.

The whole trick in using the gauge is the interpretation of the readings you get. To start, you'll need to know the normal vacuum specs for your engine. Check the service manual or ask a dealer.

There's an important point to remember concerning a normal vacuum reading. Readings vary with altitude, and what's normal at 2000 feet above sea level is not necessarily normal at sea level. A vacuum gauge is calibrated for sea-level operation. For every 1000 feet you are above sea level, subtract one inch of vacuum.

Before testing vacuum, start the engine and let it warm up for about 10 minutes. Then, with the gauge connected, run the engine at idle.

A needle that holds steady or has only a slight flutter at or above the minimum allowable vacuum for your engine indicates that all is well. However, a low reading or a vibrating needle indicates a problem. But how can you tell whether the trouble is with carburetor, valves, intake manifold, timing or what? By looking at the gauge's needle to see what it's doing. Look first for an indication that carburetor adjustment is faulty and that ignition timing is off.

A tip-off to a faulty carburetor adjustment is a needle that slowly floats over a range of 4 to 5 inches.

troubleshooting . . .

VACUUM GAUGE

By MORT SCHULTZ

Before proceeding with your tests, readjust the carburetor for correct idle. You can use the vacuum gauge: Turn the idle adjustment screw to the right or left until the needle of the vacuum gauge reads the highest, most steady point. That's all there is to it.

However, if in turning the idle-adjustment screw to the right or left the vacuum gauge needle can't be made to dip to the left, it means that the carburetor idling adjustment is not working properly. Immediately, this tells you that the carburetor is dirty. It should be removed, dismantled, cleaned and set to specs.

Ignition, engine tests

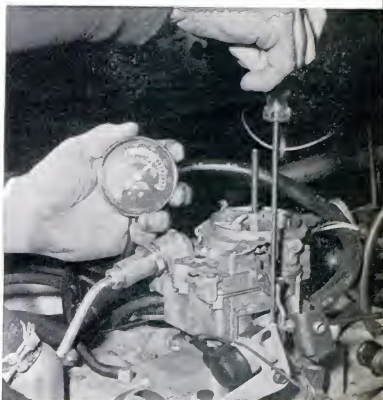
The vacuum gauge can also tell you if ignition timing is okay. If the gauge's needle is holding steady, but is lower than the minimum that's allowed for your engine, it means either that ignition timing or valve timing is off. Rule out ignition timing by making the following check:

Hook up a timing light to No. 1 spark-plug terminal. Start the engine and note the timing. If it's not correct, rotate the distributor housing against rotor rotation to advance the timing—or, with rotor rotation, to retard the timing.

With carburetor and timing properly tuned, you can now use the vacuum gauge to check the engine. Start by making a cranking vacuum test, which gives you an overall indication of the engine's condition.

Connect a jumper lead from the distributor primary terminal to ground to keep the engine from starting while cranking. Back out the throttle stop screw and release the automatic choke so the throttle valves are tightly seated.

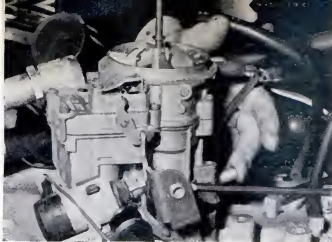
If your engine is equipped with a positive crankcase ventilation (PCV) system,



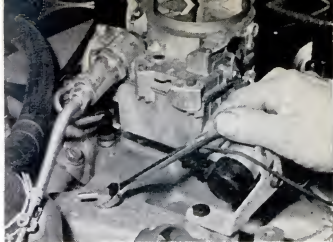
HIGH, STEADY READING during idle adjustment (above) shows carb is clean. Back out throttle stop screw (below) to shut throttle valve for cranking test



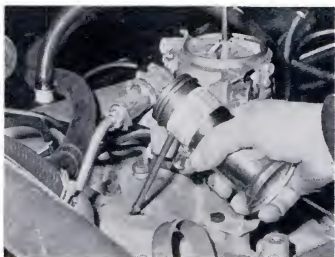
Vacuum gauge reading	Problem	Remedy and comments
	Needle floats over range of four to five inches	Faulty carburetor adjustment Perform appropriate adjustment or repair
	Needle steady but below normal	Faulty ignition timing Perform appropriate adjustment or repair
	Needle drops intermittently about four inches	Valves are sticking Check by injecting penetrating oil into the intake manifold. If intermittent vacuum drop stops temporarily, you can be sure valves are sticking. Remove them for reconditioning
	Needle drops back to constant low reading, returns to normal, drops back, and so on	Burned valve or insufficient valve tappet clearance causing leaky valve Gauge needle drops back whenever the burned valve or the valve that isn't closing is in operation. Replace or adjust valve
	Normal and steady reading at engine idle, but vibrating reading at high engine speed	Weak valve springs Perform appropriate adjustment or repair
	Needle vibrates excessively at idle, but steadies as engine speed is increased	Worn valve guide stems Perform appropriate adjustment or repair
	Excessive needle vibration at all speeds	Leaky head gasket Perform appropriate adjustment or repair
	Steady, but low reading	Improper valve timing Failure to obtain normal reading could also mean that ignition timing is off, but this possibility should be eliminated beforehand as indicated above. If necessary, adjust valve timing
	Slow drop of needle to zero as engine speed is increased	Restricted exhaust system Perform appropriate adjustment or repair
	Needle holds steady but below normal	Stuck throttle valve or leaky intake manifold or carburetor gasket Verify by turning ignition off, closing throttle valve by backing out throttle stop screw and connecting a jumper lead from distributor primary terminal to ground. Crank the engine. The needle should quickly rise to normal. If it does not, one of the problems noted is the cause. To pinpoint vacuum leak, squirt oil around joints and test again. A temporary normal reading indicates a faulty gasket



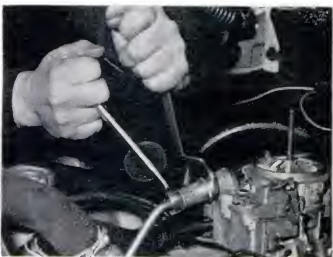
CLOSE PCV SYSTEM before reading vacuum by removing hose at carburetor, plugging port and hose



VACUUM PORT PLUG is removed for access to intake manifold as first step in checking for sticking valves



SQUIRT OIL INTO MANIFOLD through vacuum port and run vacuum test again to check suspect valves



FUEL-PUMP PRESSURE can easily be checked by inserting gauge in fuel line between line and carb

plug the system closed at the carburetor end, but remember to unplug it after the test. This way, you insure that a faulty PCV isn't affecting engine vacuum. Crank the engine and note the reading.

A high steady vacuum up to manufacturer's specifications signifies a mechanically sound engine—one with a properly sealed intake manifold and intake valve guides and a normal cranking speed. The needle may pulsate slightly, but should be even.

An uneven, pulsating reading signifies defective valves, rings, pistons or head gasket.

A low, even, and pulsating reading means that overall compression is low, valve timing is incorrect, throttle valves are not tightly closed, or there are vacuum leaks existing at the intake valve guides, in the manifold or in some vacuum accessory.

A poor reading should be followed up with a verifying check. The accompanying chart, which shows how the needle may react and what that reaction means, provides a quick guide to interpreting

vacuum-gauge readings. Unless noted, these tests are conducted with the engine running at idle speed.

The solid needles indicate a fluctuating reading, while the outlined arrows show a steady reading.

At this point, one other major possibility remains—low compression. You can verify this by removing all sparkplugs and then testing the compression of each cylinder.

Many vacuum gauges are calibrated to measure fuel-pump pressure. These are the ones that have an auxiliary pounds pressure scale, which usually reads to seven pounds. To test the fuel pump, disconnect the carburetor-to-fuel-pump fuel line at the carburetor and connect the gauge to the line. Start the engine and run it at idle speed. Fuel-pump pressure should be up to spec.

Pressure should hold steady for several minutes after you stop the engine, then it should gradually fall to zero. Failure to hold steady indicates a worn fuel pump valve, a broken pump diaphragm or leaks around the diaphragm. ★★★

How to Troubleshoot

By HENRY B. NOTROM

START WITH A PENCIL and paper. Make some notes on just what's wrong with your outboard and how it started going wrong. Consult a service manual. Then, and only then, reach for your tools.

This is the systematic approach to troubleshooting, a scientific method of finding out what's wrong by ruling out what isn't wrong. Does it work?

"Like a charm," say graduates of the Outboard Marine Corp. Training Center at Fairfield, N.J. Here, students learn by means of audio-visual teaching machines, cutaway engine models and other modern educational aids. Even the old-time pros are discarding methods they've used for years after being introduced to this up-to-date approach. So why not you?

The first thing you do is write down all facts relating to the problem. When did it start? How did it start? What are the symptoms? Have you taken any corrective action? If so, what?

Often a remedy may be suggested just by seeing the problem on paper, especially if it resembles a problem you've encountered in another engine. Not long ago, for example, my car developed an intermittent starting problem. Finally it wouldn't start at all. The trouble was a clogged fuel filter. Based on this experience alone, one of the first things I'd check if my outboard acted the same way would be the fuel filter.

Don't go off half cocked just on the basis of experience, though. If one or two simple checks fail to solve the problem, the best thing to do is to isolate the trouble and proceed from simple to more complex remedies. In my case, I would have looked pretty foolish with carburetor parts strewn all over the workbench, only to discover that my automatic choke linkage was dirt-clogged.

When attempting to isolate the trouble, keep in mind the three fundamentals of internal combustion engine operation: a correct mixture of *fuel* introduced into a cylinder is *compressed* and then *ignited*



CHECKING PLUGS in problem motors can answer many questions. If plug is dry, as above, there's trouble in fuel system—if wet, recheck ignition system

by a properly timed spark of the right intensity. When one of these three essentials is missing, you've got trouble.

Turn the flywheel over slowly by pulling the starter cord. If you feel a kick-back, you can rule out compression as a cause of trouble. If there is no snap and the flywheel mushes through, however, bad compression is probably the cause of your problem.

Check for spark by removing a plug from a cylinder, grounding it against a spot on the powerhead and cranking the engine. If you get a good, strong spark, you can rule out ignition as a cause. Finally, check sparkplug electrodes. If dry, the problem is in the fuel system.

Now you're ready to consult the troubleshooting charts in your service manual.

Like a Pro

If you don't already have a manual, one can be ordered for about \$3 from either the manufacturer of your motor or Abos Marine Div., Technical Publications, Inc., 1014 Wyandotte St., Kansas City, Mo. 64105. Be sure to give all information about your engine (for example, 1967 Evinrude 3-hp Lightwin, Model 3707).

Troubleshooting charts outline several courses of action under each major trouble area. You start with those that take only a few minutes and go on to more complex remedies.

Suppose your engine won't start and you've isolated the problem in the fuel system. The manual suggests actions ranging in complexity from checking to be sure you have fuel in the tank to tearing the fuel system apart. It goes like this:

1. Make sure you have fuel in the tank.
2. Make sure that the fuel shut-off valve is opened.
3. Make sure that the vent-cap screw is opened.
4. Make sure that the speed control is advanced.
5. Make sure that the choke is completely closed.
6. If the fuel filter has been in use for some time, clean or replace it.

Only after you've tried these remedies does the manual recommend tearing apart the fuel system. And to make sure you don't make a mistake, it includes specific, detailed instructions on just how to go about taking the fuel system apart and trying those complex remedies. It's almost impossible to go wrong.

To sum the whole thing up, you should:

- Write down all facts about the problem.
- Use past experience to suggest a quick solution.
- If experience doesn't help, isolate the trouble in one of the three major areas.
- Consult the troubleshooting charts in your service manual to guide you in tracking down the source of trouble through the process of elimination. Fix the problem and you're ready to go. ★★

Readers' Questions

Q. *I would like to equip my boat with a kit made up of all the spare parts and tools which I would need for emergency on-water servicing of my engine. Could you list the items that you consider important?*—J.W., Ore.

A. Sure—spare sparkplugs, a sparkplug wrench, an adjustable wrench, friction tape, a spare propeller and prop nut, cotter and shear pins, pliers, a screwdriver and your owner's manual.

Q. *When I started to clean up my motor this spring, I found that I'd forgotten to empty the old gas out of the tank last fall. I dumped the old fuel, since I know this could gum up the carburetor. What else should I do to finish the clean-up job?*—S.R., Va.

A. Start by pouring acetone or lacquer thinner into the tank. Slosh it around, then pour it out. Next, remove the fuel filter and bowl and give them a good cleaning with the same solvent. This will get rid of any gummy deposits.

Q. *My 6-hp Evinrude suddenly began to lose power and developed an intermittent vibration which only shows up when under way. What's wrong?*—T.B., Ohio.

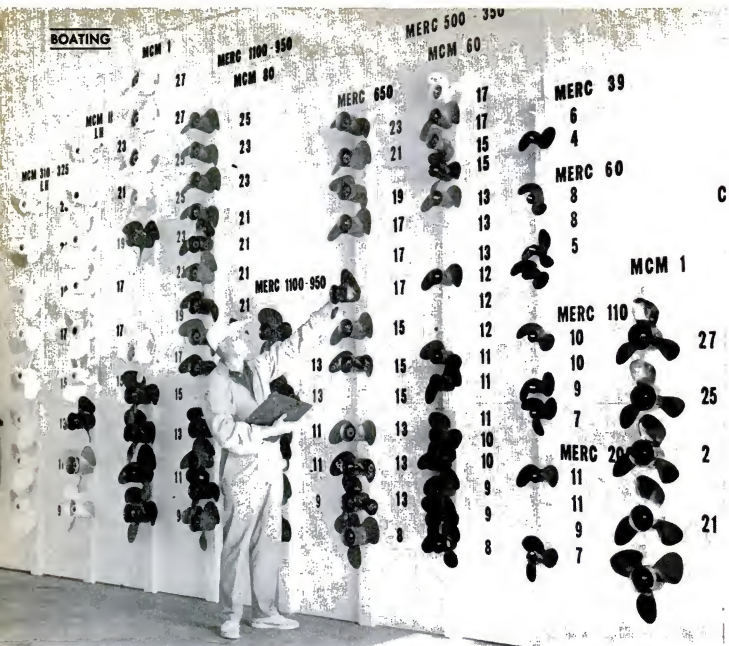
A. When both these conditions develop simultaneously, it usually means that the prop has been damaged. Bent or nicked blades will produce a loss of rpm and vibration (caused by the engine and prop being out of balance). Even if the prop looks okay, I'd remove it and take it to a shop for testing on a pitch block to be sure it's not out of true.

Q. *I'm using sparkplugs at the rate of a pair every two weeks. How can I correct whatever is wrong?*—T.J., Me.

A. Sounds as if you're adding too much oil to the gas. This is the main cause of plug failure in outboard engines. I'd check the ratio in your owner's manual and be careful to follow it. Plugs should last a full season.

SEND YOUR QUESTIONS to Outboard Clinic, Popular Mechanics, 575 Lexington Ave., New York, N.Y. 10022. While we can't answer all letters, your question—or one like it—will probably show up in the column.

BOATING



PROPELLER WALL at Merc's Boathouse Bulletin garage holds most popular of company's 198 outboard props

The Right Prop for Your Boat

There's a good chance that you can get a boost in performance by switching props. To find out for sure, try this easy test

By ART MIKESELL

THE SOLE FUNCTION of a propeller is to turn power into push. With the right prop your boat will be a joy to operate, an agile, responsive rig running at top efficiency. Any other prop is a step in the wrong direction, because it won't deliver all the push your engine can provide.

Most boats today are running with props that do not quite match the requirements of the motor, hull and boat owner.

When you buy a motor, you have to choose a prop on the basis of the motor manufacturer's recommendations as listed on a prop selection chart. These recommendations are based on horsepower, boat length, gross load and intended use. They're designed to prevent you from making a bad error in prop selection by limiting your choice to a comparatively small number of propellers, any one of

which will give reasonably good performance. The chart is just a guide.

The only sure way to make your selection is to test a number of recommended props against each other *on your rig*. Unfortunately, this is impossible since the dealer isn't in a position to loan out props for testing purposes. Thus, you and your dealer have to make the best possible guess on the basis of the prop chart and past experience with similar rigs.

However, *don't* buy a spare prop at the same time. Instead, spend a few hours some afternoon testing the prop you bought, then go back and choose a spare on the basis of your tests. This gives you a second chance at picking the perfect prop.

You'll need a stop watch, a quarter of a mile or so of uncluttered water and, most important, a tachometer.

The tach is the key to the whole test. Any engine has a relatively narrow rpm range within which it delivers peak horsepower. Running slower, it's not delivering all the power it was designed to produce. Running faster, it's subject to excessive strain and actually may deliver less power due to friction and other internal engine conditions. A tach is the only way to find out if you're in the peak horsepower range for your motor.

A first requirement for the perfect prop is that it should allow the engine to reach peak rpm range when you run your rig at

FOR EACH TEST, we selected six props from the list of 17 different wheels recommended for the Merc 650. Turn the page to find out the results of these performance tests in propping three typical runabouts



FLYING QUARTER speed tests were run on a surveyed quarter-mile course. As Saber 15-V streaks across the finish line, stop-watch time is noted and tach reading is taken to check on prop's performance

FINAL FIGURES were arrived at by averaging the results of runs in both directions through the course. Towing rig mounted on the stern was used in testing props for skiing. You'll find the results on page 124



full throttle with an average load. If you normally carry three other people in your boat, take along three people when you run your tests. If interested mainly in skiing, run the trials while towing a skier.

Begin with a full-throttle run through the course you've chosen. This should be at least a quarter of a mile long, since differences in speed will show up in fractions of seconds even at that distance. Note the time it took to run the course and the rpm level at the finish.

The tilt-pin setting should be about midway between the extremes for this first run. For the next, move the motor one notch in. Then move it one notch out beyond the first setting and make a third run. If either the second or third runs result in better times or rpm readings, tilt the engine a notch more and try again.

From these speed runs, you can determine the right tilt-pin setting and where your rpm level is in relation to that peak horsepower range.

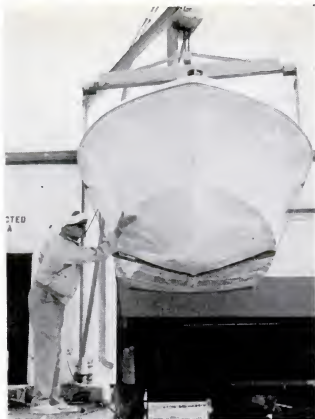
To test low-end performance, make a number of runs from a standing start through a short course—50 ft. or less will usually do—to check how fast the boat climbs to planing attitude.

Once you've made all these tests, gather up all your notes and head back to your dealer's shop to pick out a spare prop. Since prop selection charts are arranged in easy gradations with "speed" at one end and "push" at the other, your performance notes should provide the necessary information on the direction you should go.

To show you the variety of results that can be obtained from different props, PM enlisted the cooperation of Kiekhaefer Mercury. This company not only makes more than twice as many different propellers as any of the other outboard manufacturers, but works in close cooperation with boat builders to arrive at specific horsepower and propeller recommendations for different boats.

We used three different runabouts which had been shipped to Merc's Salt Water Corrosion Testing Facility for testing under the company's "Boathouse Bulletin" program. Here, Merc test drivers run the boats with different engines and propellers. The resulting recommendations on power, engine mounting height, propeller and tilt-pin setting are supplied to both Merc dealers and the boat manufacturer. Gene Wagner, resident engineer

HOW WE PROPPED



SPORT-CRAFT SAFARI 17 fiberglass runabout made by Sport-Craft, Inc., Box 351, Perry, Fla.

Centerline length: 16' 3" Beam: 6' 11"
Net weight: 985 lbs. Gross load: 1655 lbs.
Tilt setting: 3rd pinhole

- 13 x 17" two-blade bronze**
Flying quarter: 29.2 sec. @ 4900 rpm
Acceleration (standing start through 30'): 6 sec. @ 3850 rpm
- 12 x 17" three-blade aluminum**
Flying quarter: 29.1 sec. @ 5000 rpm
Acceleration: 6 sec. @ 3950 rpm
- 13 x 15" two-blade aluminum**
Flying quarter: 29.3 sec. @ 5400 rpm
Acceleration: 5.5 sec. @ 4500 rpm
- 12½ x 15" three-blade aluminum**
Flying quarter: 29.3 sec. @ 5450 rpm
Acceleration: 5.6 sec. @ 4500 rpm
- 13¼ x 13" two-blade aluminum**
Flying quarter: 30.4 sec. @ 6050 rpm
Acceleration: 5.4 sec. @ 5100 rpm
- 13 x 13" three-blade aluminum**
Flying quarter: 30.6 sec. @ 5900 rpm
Acceleration: 5.3 sec. @ 5100 rpm
- 12½ x 15" three-blade aluminum (1st pinhole)**
Flying quarter: 29.7 sec. @ 5200 rpm
Acceleration: 5.2 sec. @ 4400 rpm

CONCLUSIONS: Obviously, the last test shows the best characteristics for skiing and general use. If you want all-out speed, the 12 x 17" three-blade has a slight edge, but any increase in load would probably eliminate this advantage.

* All tests were conducted at Kiekhaefer's Salt Water Corrosion Testing Facility in Sarasota, Fla., with Gene Wagner, resident engineer, serving as boat driver for all runs. The same Mercury 650SS engine was used in testing all props. (Full-throttle rpm range for this motor is listed as 4800-5200 on the Mercury Prop

THREE TYPICAL RUNABOUTS*



SABER 15-V fiberglass runabout made by Critchfield Marine, Rt. 7, Box 569C, Orlando, Fla.

Centerline length: 15' 9" Beam: 6' 1"
 Net weight: 540 lbs. Gross load: 1210 lbs.
 Tilt setting: 3rd pinhole (18° transom)

12¼ x 21" two-blade bronze

Flying quarter: 27.3 sec. @ 4100 rpm
 Acceleration (standing start through 30'): 5.6 sec. @ 3100 rpm

12½ x 19" two-blade bronze

Flying quarter: 26.2 sec. @ 4600 rpm
 Acceleration: 5.2 sec. @ 3600 rpm

13 x 17" two-blade bronze

Flying quarter: 26.4 sec. @ 4850 rpm
 Acceleration: 4.8 sec. @ 3800 rpm

12 x 17" three-blade aluminum

Flying quarter: 26.1 sec. @ 4950 rpm
 Acceleration: 4.4 sec. @ 4000 rpm

13 x 15" two-blade aluminum

Flying quarter: 26.4 sec. @ 5250 rpm
 Acceleration: 4.4 sec. @ 4400 rpm

12½ x 15" three-blade aluminum

Flying quarter: 26.6 sec. @ 5200 rpm
 Acceleration: 4.4 sec. @ 4300 rpm

12½ x 19" two-blade bronze (5th pinhole)

Flying quarter: 23.8 sec. @ 4800 rpm
 Acceleration: 5.4 sec. @ 3400 rpm

CONCLUSIONS: Best choice is the 12½ x 19" which gives quite good acceleration in 3rd pinhole and excellent top speed in 5th without over-revving as lower-pitch prop probably would. The 12 x 17" is best for push, but not so good for speed.



MFG CORVETTE fiberglass runabout made by Molded Fiberglass Boat Co., Box 266, Union City, Pa.

Centerline length: 14' 10" Beam: 5' 10"
 Net weight: 619 lbs. Gross load: 1289 lbs.
 Tilt setting: 3rd pinhole (12° transom)

12¼ x 21" two-blade bronze

Flying quarter: 24.5 sec. @ 4800 rpm
 Acceleration (standing start through 30'): 6.3 sec. @ 3400 rpm

12½ x 19" two-blade bronze

Flying quarter: 24.5 sec. @ 5050 rpm
 Acceleration: 5.8 sec. @ 3800 rpm

13 x 17" two-blade bronze

Flying quarter: 25.7 sec. @ 5250 rpm
 Acceleration: 5.5 sec. @ 4000 rpm

12 x 17" three-blade aluminum

Flying quarter: 25 sec. @ 5450 rpm
 Acceleration: 5.6 sec. @ 4100 rpm

13½ x 13" two-blade aluminum

Flying quarter: 27.5 sec. @ 6100 rpm
 Acceleration: 4.9 sec. @ 5200 rpm

13 x 13" three-blade aluminum

Flying quarter: 28.3 sec. @ 6100 rpm
 Acceleration: 4.8 sec. @ 5200 rpm

CONCLUSIONS: While this hull is entirely different from the Saber at left, the gross load turned out to be approximately the same and so it's not surprising that the same 12½ x 19" prop proved to be best for both boats. Lower pitches have a tendency to exceed the recommended rpm limit, and the higher pitched prop doesn't offer as good performance on the low end.

Selection Chart.) The "flying quarter" time for each prop was determined by running the boat at top speed through a surveyed quarter-mile course, then swinging around and making another speed run back through the course. Each run was timed with a stop watch, and an AquoMeter tachometer was used to take rpm readings at each finish

line. The figures given are two-way averages. Acceleration was determined by timing the boat from a standing start through a 30-ft. course, a distance which proved more than adequate for each boat to climb to a plane. Time and rpm figures are averages of three such runs, all held under similar wind, tide and wave conditions.

PICKING A SKI PROP

Our test boat was the Saber 15-V described on the preceding page, with the addition of a dynamometer borrowed from Puritan Cordage Mills to measure drag. Our skier, pert blonde Lyn Gregorio, weighed 110 lbs. and used standard twin skis from a deep-water start. Maximum drag each time was just over 110 lbs.—the force required to overcome Lyn's inertia and pull her up to skim over the surface. This dropped rapidly to a running drag of around 55 lbs. once the boat reached top speed.

12½ x 19" two-blade bronze

Pop-up time: 2.2 sec.

Flying quarter: 27.4 sec. @ 4800 rpm

12 x 17" three-blade aluminum

Pop-up time: 2.2 sec.

Flying quarter: 26.8 sec. @ 5000 rpm

12½ x 15" three-blade aluminum

Pop-up time: 2.3 sec.

Flying quarter: 27 sec. @ 5400 rpm

CONCLUSIONS: While there was little difference in pop-up time, the 12 x 17" prop showed two definite advantages in speed runs: it not only made the best time through the quarter, but held the engine right in the middle of its recommended full-throttle rpm range. The 12½ x 19" prop recommended for general use on the preceding page would also be satisfactory for towing one light skier, but for top performance with a heavier skier or two skiers, better try a 12 x 17" prop.



and base manager, volunteered to drive.

Actually, we ran many more tests than required to pick a prop in order to show the performance possible with a number of different props. The test procedure itself, however, was basically an informed trial-and-error approach which you can duplicate with your tests.

You don't have to be a propeller engineer to understand the basic relationship between prop and performance. The two most important factors to keep in mind are pitch and total blade area.

Pitch is the distance the prop would travel in one revolution if you could screw it through a solid frictionless medium. Generally, a high pitch means speed and a low pitch indicates push power.

Blade area is a mirror image of the area of water against which the power is applied. Thus, a small blade area moves a small amount of water, and while it produces only a small amount of thrust with each turn, it lets the engine run at a high rpm level because the engine has to produce only a little power to spin the blade.

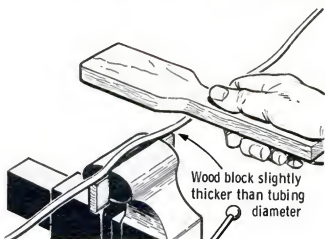
A large blade area produces more push per revolution, but also places a bigger load on the engine and cuts down the rpm.

Of course, all of this is an oversimplification since blade area and pitch go hand-in-hand. Also, there are many other design factors which enter into the performance of any prop—diameter, number of blades, blade contour, slippage and even the material from which the prop is made. (An aluminum prop, for instance, will turn at a higher rpm than a bronze prop of the same design because it's lighter.)

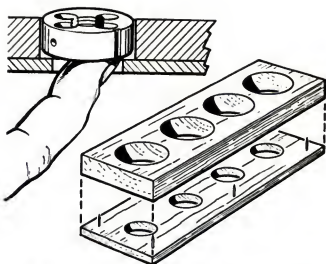
No discussion of propellers would be complete without at least a mention of cavitation. This is what happens when the prop blades fail to maintain full contact with the water. While it can be caused by underwater hull obstructions, the villain is usually the propeller itself. In extreme cases, it can cause pitting on the blades which resembles corrosion.

However, you're far more likely to run into intermittent cavitation—during starts or on turns, for instance—which results from demanding too much push from a speed prop. When this happens, the prop loses its bite and the motor lets out a high-rev scream. The only immediate solution is to throttle back and ease up to speed. To eliminate the problem for good, go to a prop with more bite. ★★★

HINTS FROM READERS



TO STRAIGHTEN copper tubing, find a scrap of lumber slightly thicker than the tubing and clamp it in your vise to make a square trough. Feed tubing through trough, tap out bends with wooden paddle



STORE BUTTON DIES in a tray made from $\frac{3}{4}$ -in. and $\frac{1}{4}$ -in. stock. Drill slightly oversize holes for dies in top board and matching $\frac{3}{4}$ -in. "push-out" holes in the bottom board. Assemble it with brads and glue

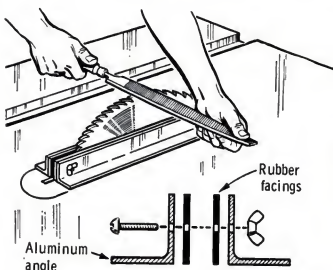
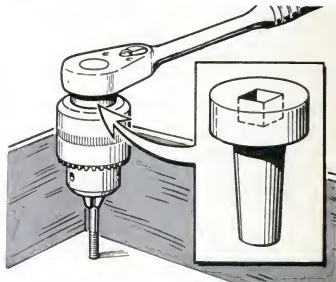
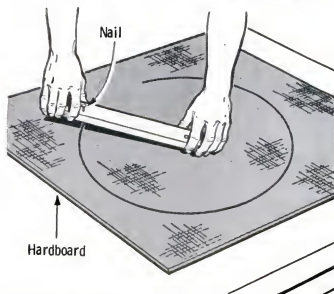


TABLE-SAW VISE made from two pieces of aluminum angle faced with strips of inner-tube rubber lets you touch up the teeth without removing the blade from its arbor. Use cement to mount the rubber strips



CHUCK ADAPTER for ratchet wrench drives threaded guide pins without marring, is also handy for tapping in close quarters. Make shank either tapered or straight-and-threaded, depending on the chuck used

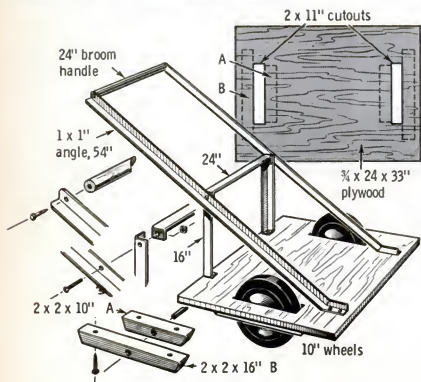


TO CUT CIRCLES from hardboard, make up a simple scribing compass from a 1 x 2 and a couple of nails. Outer nail should protrude slightly to cut groove. Cut halfway through hardboard, then turn and finish



BEACH BRACKET for your transistor radio is just a heavy rubber band stretched around the umbrella pole, as shown in the detail above. It's one good way of making sure that no sand gets into the radio case

WEEKEND PROJECTS



Tote-Cart

BACKACHES due to common back-yard chores will be greatly reduced when you use this utility tote-cart. Essentially a simple platform of plywood, square tubing and angle iron, the cart is sturdy enough to support bags of concrete mix, full trash cans, or even enough firewood for three or four evenings.

The drawing at left details the construction of this worksaver. The axle can be a 1/2-in. dia. rod, cut to a 32-in. length and held in place by two 1/2-in. shaft collars. Alternatively, the axles simply can be two suitable bolts held by nuts.—C.M. Morley



SHAPE METAL by simultaneously feeding strips between rods and bending slightly

DRILL HOLES in the pieces to be joined, then assemble bracket with three rivets

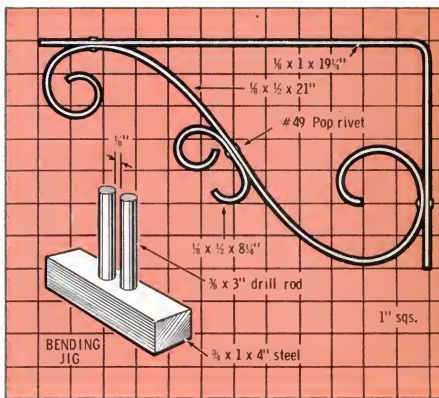


Wall Planter

AS SUITABLE for a small lamp as it is for a hanging plant, the bracket of flat stock is easy to form when you use a bending jig and a Pop RiveTool.

Make the jig by drilling two $\frac{3}{8}$ -in. holes spaced $\frac{1}{2}$ -in. apart in a small steel block. When $\frac{3}{8}$ -in. rods are fitted in the holes, the gap of $\frac{1}{8}$ -in. allows you to shape the stock as desired.

After the pieces have been formed, locate and drill the holes for the three rivets. Assemble the bracket, then wash it thoroughly before spraying it with either a black or white enamel or epoxy paint.—*John Capotosto*



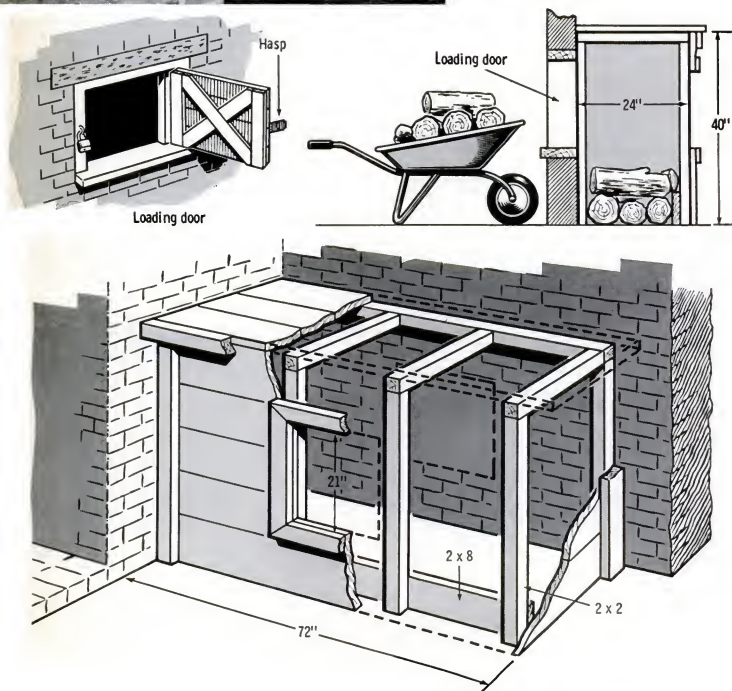


Built-In Woodbox

WITH THIS dual-access box next to your fireplace, there will be no need to run out in the cold for a log or two. Just fill it every third or fourth day and firewood will always be indoors and handy.

First step in construction is to cut an opening in the wall of the house. Then frame it in and add a suitable hinged door. Be sure to make the opening large enough to allow passage of logs cut to fit your fireplace.

The rest of the bin should be framed with 2x2s and finished to suit the interior of the house. Do not omit the 2x8—it prevents any tossed logs from knocking off the siding.—Hi Sibley



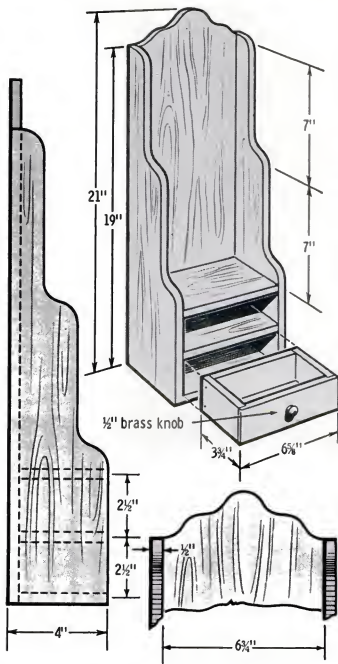
Colonial Comb Box

A DECORATOR-INSPIRED piece for homes furnished in Early American, this handsome comb box is ideal for a colonial kitchen, hall, bedroom or foyer.

Maple, pine, cherry or birch can be used to fabricate the box and the frame for the mirror. The unit shown, however, is made of golden-hued sumac, which, with its unusual grain, makes it appear centuries old.

The drawing below contains all the information necessary to complete the box. Just be certain to cut both of the scalloped sides identically by using a suitable pattern or template of hardboard or heavy paper to transfer the outline to the wood.

You can choose to use glue, brads and glue, or dowels and glue to join the parts of the comb box. The latter, however, appears more authentic.—*Don Shiner*



TRANSFER CUTTING OUTLINE to wood stock, then cut out both sides on either a bandsaw or a jigsaw

Build This Floating

Mount a patio chair between pontoons and you have the perfect rig for escaping from the heat. For even more fun, hang a fishing motor on it.

IF YOU'RE LOOKING for hustle or hurry, forget it. This low-power lounge is strictly for loafing.

Basically, it's just a folding aluminum chaise bolted between two pontoons. A stubby 2x8 transom board behind the chair back will take any of the smaller fishing motors, giving you power to putt-putt around the shallows. A steel bracket installed on the motor in place of the steering handle provides for both steering and throttle control through levers mounted on either side of the chair.

However, the motor is really just an optional bit of luxury. You'll have almost as much fun simply floating around near the dock or paddling lazily along the nearby shore. The powered version will cost around \$50 and can be built in a couple of weekends. Forget about power and you'll not only cut the cost by about 20 percent but be able to do the whole job in a day or so.

The pontoons are made of Styrofoam sandwiched between 1/2-in. marine plywood. To dress up the appearance, the exposed foam edges are covered with vinyl decking secured with epoxy.

One foam plank will provide sufficient material for both pontoons. Such planks have an irregular surface, so you'll have to dress both faces flat before splitting the plank. The easiest way to make all of these wide cuts in the foam is with a hot wire stretched between two posts.

Use nichrome resistance wire connected to a 12-v. car battery or a 6-amp. transformer. When this glows hot, it will cut

through the foam cleanly. Once the two faces have been properly dressed, you can split the plank neatly down the middle by setting the wire 6 in. above the surface and pushing the foam through it.

After cutting and sanding the plywood sides, use one of them as a template to mark the outline of the pontoons on the foam. Mark the actual cutting line 3/4 in. inside this outline. A bandsaw is ideal for cutting the foam to shape, but, lacking this, you can do a quite satisfactory job with a serrated bread knife.

Next, prepare the chair. Remove the arms and legs by drilling out the rivets with an oversize bit. To avoid alignment problems with the assembly holes, clamp the four plywood sides together and drill four holes at a time. You don't have to drill the foam, since the rods can be pushed through it easily.

To form the control bracket, heat the steel with a torch until it's cherry red, then bend it in a vise. Note that the bracket shown in the plans will work only with a 1968 Evinrude or Johnson 1 1/2-hp motor. If you plan to use another motor (nothing over 3 hp, though), you'll have to redesign the bracket as necessary.

From this point on, the detailed plans

USE HOT WIRE to dress Styrofoam plank, taking power from 12-v. car battery or 6-amp. transformer

MARKING PEN (center right) works fine for tracing pontoon outline on foam. Cut 3/4 in. inside mark

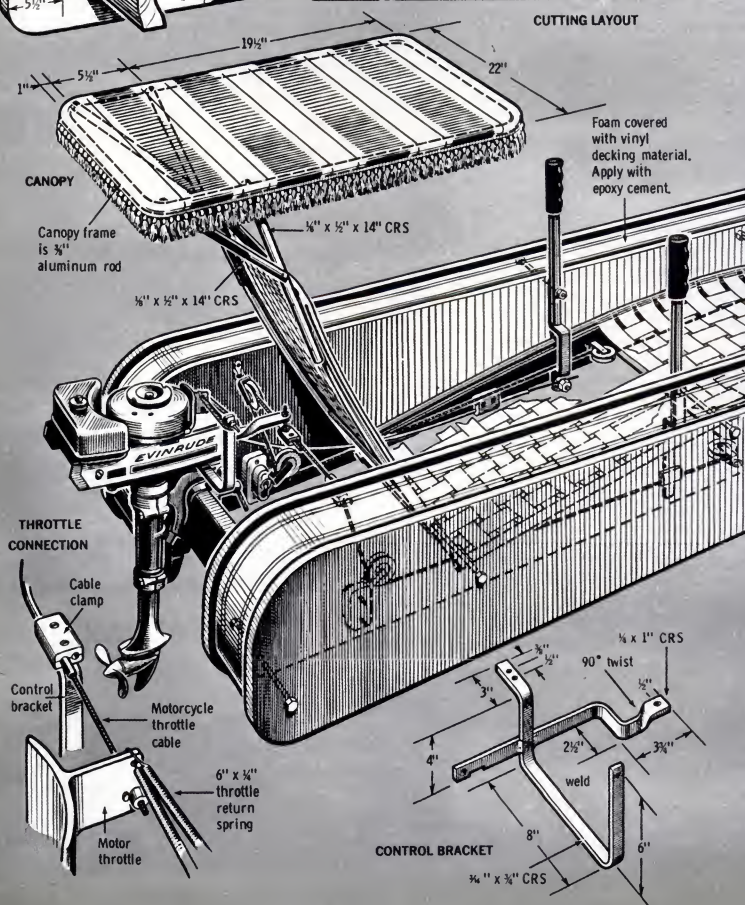
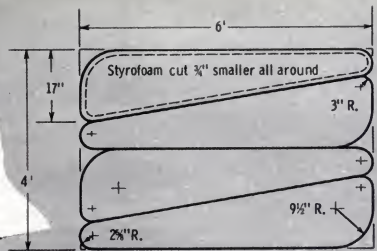
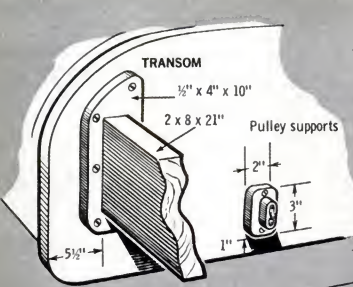
CONTROL BRACKET (extreme right) takes place of steering handle, lets you operate motor from seat

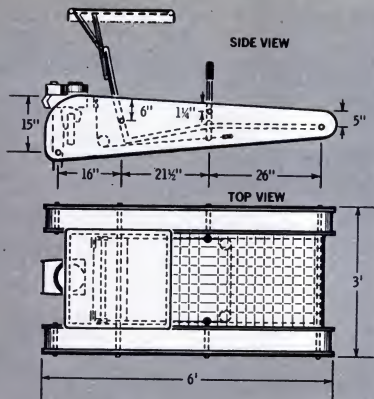


Lawn Chair

By John Capotosto







PM's SIT-ABOUT



3/8" o. d. x 17"
aluminum
tubing —

1/2" x 9"
hex-head

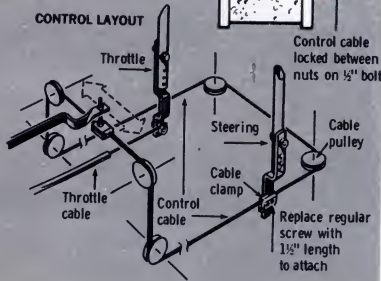
hex-head
bolt Washers

Washers

¼-20 x 1"
hex-head
screws —
spaced
1½" apart

Foam
6" thick

cut here -
for steering
lever



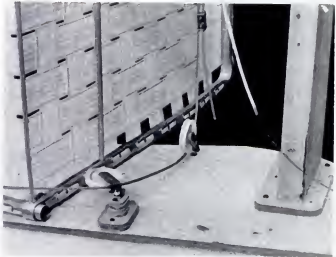
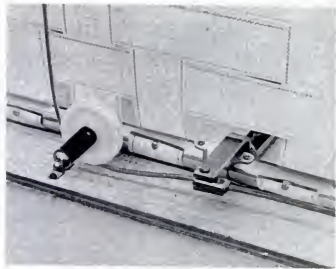
Control cable
locked between
nuts on $\frac{1}{2}$ " bolt

	Cable
--	-------

Cable
pulley



Replace regular
screw with
1/4" length
attach



BILL OF MATERIALS

Amt.	Size, Description (Use)
1	Folding aluminum lawn chair 22" wide
1	7" x 20" x 5 Styrofoam plank (floatation)
1	1/2" x 4' x 6' marine plywood (sides)
2	1/2 x 4 x 10" marine plywood (transom ends)
2	1/2 x 2 x 3" marine plywood (pulley supports)
4	1/2 x 3/4 x 1 1/2" marine plywood (pulley supports)
1	2 x 8 x 21" fir (transom)
2	7/8" a.d. x 17" aluminum tubing
2	1/8 x 1 x 15" cold-rolled steel
3	3/8 x 3/4 x 22" cold-rolled steel
1	1/4 x 1 x 16" cold-rolled steel
4	1/8 x 1/2 x 14" cold-rolled steel
6	Pulleys for 3/16" vinyl-covered control cable
3	Cable clamps
24	1 1/2" No. 8 flathead brass screws
3	1/4—20 Shakeproof nuts
2	1/4—20 x 1 1/2" screws
2	3/8" x 8' aluminum rod
10	3/8—24 nuts, with washers
4	1/8 x 1/2 x 14" cold-rolled steel
2	Bicycle hand grips
1	Motorcycle control cable
1 yd.	Dexide or Nantalex vinyl decking
15 ft.	1/16" vinyl-covered control cable
2 ft.	22-g. Nichrome V wire (for trimming the foam)

Build this Cookout Bar

The whole family can join in the fun of building and using this elegant patio-grill



MAYBE YOU ALREADY HAVE a portable grill and find it adequate, but when it comes to real outdoor entertaining, southern style, you can't beat a cookout bar like this one.

For one thing it's big enough to let you host a king-size crowd. On its two grills you can play chef like a pro. You can have hamburgers working on one and steaks broiling on the other. The big wide counter gives you room to spread out a buffet. Charcoal and hickory chips are nearby in handy storage bins. Water, electricity and a phone make you independent of the house, and the connecting patio lets both Beatle friends and squares have a ball on its slick tile surface. Two yellow yardlights add a glow to the



for Summer Fun

CONSTRUCTION

By Robert D. Borst
Photos by the Author



A PLACE for both dining and dancing, this elegant-looking back-yard patio is just right for the young and old alike. When cleared of the tables and chairs, the tiled area paves the way for teen-age twisters to make their summer parties at home a real ball for the younger set. And, of special appeal for the older members of the family, the cookout bar comes equipped with everything except the kitchen sink, though there's running water



PATIO EXCAVATION IS MADE 13 in. deep (upper left) from a level string. Then the area is covered with a layer of fine sand (above, center) and raked smooth to a depth of 9 in. (above, right). After sprinkling with water from hose, sand is tamped (left) to form firm 8-in. bed for concrete. Footings are dug 18 in. deep inside separate form boards and filled with rock

spirit of things, and a low cushion-fitted wall provides extra seating for lap diners or party poopers.

The chances are you won't build yours exactly like mine. You may just settle for a poured patio and not bother tiling it. Maybe the cookout bar is all you'll want to add to a patio you already have. You may be happy with just one grill.

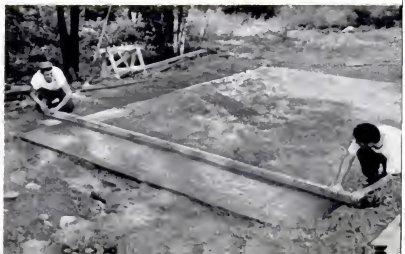
Whatever ideas you borrow, construction is basically the same, whether you make your setup large or small, plain or fancy. If you do plan to tile the patio, it's wise to make it a size which will accept a given number of full tiles (not forgetting mortar joints) so you won't have to cut any. I used 6-in. quarry tiles and bedded them in mortar, following instructions furnished by the Tile Council of America.

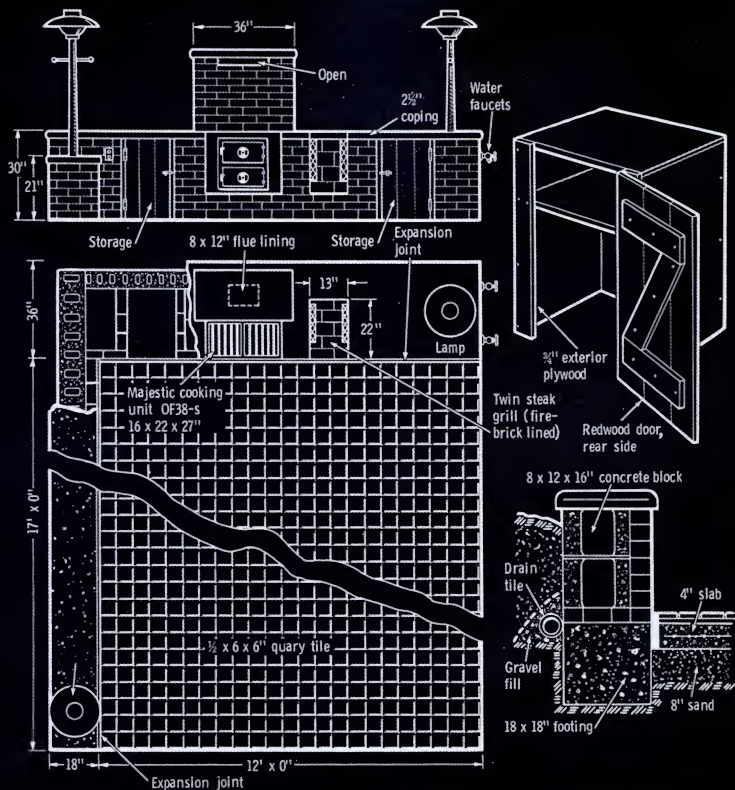
The photos on these two pages show the steps I followed in building the patio section. This involved leveling off the area, covering it with a 9-in. layer of sand, sprinkling this

(Please turn to page 184)

STEEL RODS and welded wire fabric are both used to reinforce the concrete slab and guard against possible cracking by freezing and heaving action of earth

FOOTINGS ARE POURED FIRST and struck off level with a straightedge. Then forms are removed and strips of expansion felt inserted before pouring slab





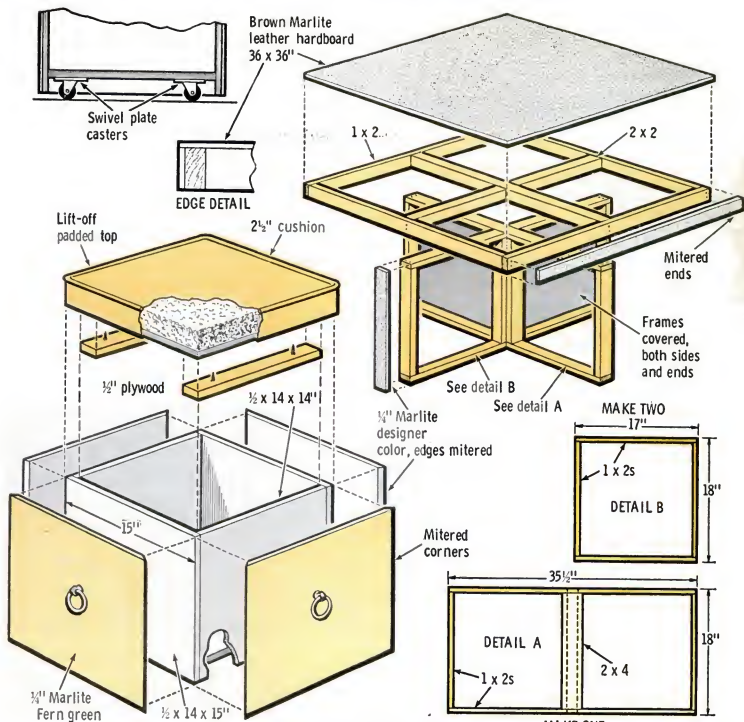
ROUGHENING THE SURFACE by raking lightly gives partially set concrete a "tooth" for bonding tile to it with a mortar bed. Tile is grouted in usual manner

BUILDING PAPER OR BURLAP laid over poured slab keeps concrete from drying too fast. Keep covering moist by spraying with water once a day for a week



Build This Stool Table





Technical Art By Don Evans

A REAL MISER when it comes to saving space, this table makes every inch count. Four box stools tuck under its top to provide instant roll-out seats, and each stool offers wonderful hidden storage under its lift-off cushion.

As a coffee table you'll find it the handiest thing ever for late-show snacks. As a game table it's marvelous for the kids' room. You'll even find the stools handy for extra seating when entertaining.

To top it off, it's an elegant looking piece of furniture for it is completely covered with both a textured and a slick plastic-finish hardboard paneling from Marlite.

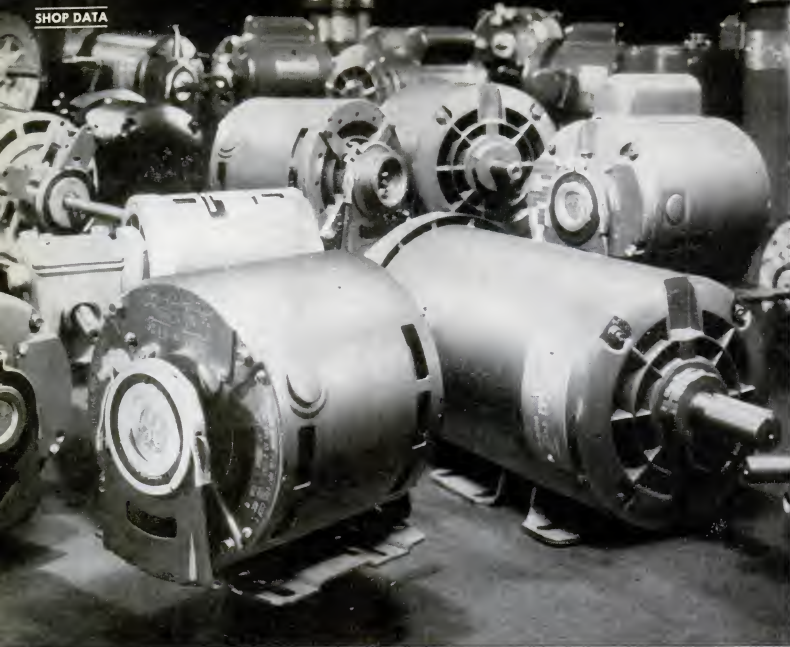
The 3/8-in.-textured leather top is supported by a 35 1/2-in.-sq. frame of 1x2s and 2x2s, glued and nailed together. The 2x2s

are notched to half-lap at the center.

The tabletop, in turn, is supported by a crisscross base consisting of three 1x2 frames joined together at the center. The brown leather top laps the edges of the hardboard strips applied to edges of the frame, while the joints of the fern-green members covering the base are mitered at outer corners. Regular panel adhesive is used to cement the hardboard in place.

The stools are made alike, starting with a box of 1/2-in. plywood. The bottom is recessed so that ball casters, such as Shepard's, will raise the stool about 1/2 in.

The padded seat is foam rubber placed on top of a 15-in. square of plywood and covered with a fitted vinyl top which is tacked to the underside. ★★★



A Guide to Electric Motors

WHEN YOU NEED a replacement motor for an appliance or workshop tool, ordering a new unit is easy enough—just take the necessary data from the motor's nameplate. But when you're scratch-building a worksaver like a bench saw, don't make the common mistake of selecting a motor by simply guessing.

Actually there are four factors you must consider before making a choice: horsepower rating, starting effort, shaft speed and operating voltage.

Horsepower is the primary consideration (one hp will lift 33,000 lbs. one ft. in one minute). As an indication of requirements for different jobs, the table on the opposite page lists motors of various horsepower and their typical uses. If your particular application is not listed, simply

compare it to a similar job and select the next larger motor to avoid overloading. This is especially important where low voltage conditions or fluctuations may be encountered (as on a farm).

Continual overloading of a motor above its rated power can cause it to overheat and shorten its life. For this reason, most new fan, blower, pump, compressor and conveyor motors have automatic-reset overload protection to guard against such overheating. It's important that the thermal protector automatically resets the motor in installations like a furnace blower, where you would not want the furnace to remain inoperative overnight, or on water pumps located away from the house. A manual-reset overload device, however, is recommended for motors that drive

COMMON USES FOR ELECTRIC MOTORS

APPLICATION	HORSEPOWER	SPEED	MOTOR TYPE
Belt sander, 4"	1/4	1725	Split-phase
Belt sander, 6"	1/2	1725	Capacitor-start
Belt sander, 10"	1	1725	Capacitor-start
Belt-driven blower	1/8-3/4	1725	Split-phase
Churn	1/3	1725	Split-phase
Small compressor	1/8-3/4	1725	Capacitor-start
Small concrete mixer	1/2	1725	Capacitor-start
Cream separator	1/2	1725	Capacitor-start
Drill press, 1/4"	1/3	1725	Split-phase
Drill press, 1/2"	1/2	1725	Capacitor-start
Drill press, 3/4"	3/4	1725	Capacitor-start
Belt-driven fan	1/8-3/4	1725	Split-phase
Feed mixer, 15-bushel	3/4	1725	Capacitor-start
Feed grinder	3/4	1725	Capacitor-start
Flexible shaft, 5/16" dia. x 50'	1/3	1725	Split-phase
Flexible shaft, 1/2" dia. x 75'	1/2	1725	Capacitor-start
Wheel grinder, 6"	1/3	1725	Split-phase
Wheel grinder, 7"	1/2	1725	Split-phase
Wheel grinder, 8"	1	1725	Capacitor-start
Jigsaw, 12 or 15"	1/4	1725	Split-phase
Jigsaw, 18 or 25"	1/3	1725	Split-phase
Jointer, 4 1/2"	1/2	3450	Capacitor-start
Jointer, 6"	1/2	3450	Capacitor-start
Jointer, 8"	3/4	3450	Capacitor-start
Lathe (metal), 6"-swing	1/2	1725	Capacitor-start
Lathe (metal), 10"-swing	3/4	1725	Capacitor-start
Lathe (wood), 8"-swing	1/3	1725	Split-phase
Lathe (wood), 12"-swing	3/4	1725	Capacitor-start
Small meat grinder	1/4	1725	Split-phase
Oil burner	1/8-1/4	1725	Split-phase
Small paint sprayer	1/3	1725	Capacitor-start
Planer	3/4	3450	Capacitor-start
Jet pump	1/3-2	3450	Capacitor-start
Sump pump	1/3	1725	Split-phase
Pump jack	1/2	1725	Capacitor-start
Bandsaw, 8" throat	1/3	1725	Capacitor-start
Bandsaw, 10, 12 or 14"	1/2	1725	Capacitor-start
Bench saw, 6 or 7"	1/2	3450	Capacitor-start
Bench saw, 8"	3/4	3450	Capacitor-start
Bench saw, 10"	1	3450	Capacitor-start
Spindle shaper	1/2	3450	Capacitor-start
Stoker	1/3	1725	Capacitor-start

Courtesy General Purpose Motor Dept., General Electric Co.

A Guide to Electric Motors (Continued)

potentially dangerous tools, such as a saw, jointer or lathe.

Load moving is critical when you start a motor. Machines such as free-running saws or fans are easy to start. Others that must start under load—such as concrete mixers, conveyors, pumps and air compressors—need motors with extra turning strength, or torque, during the starting revolutions. For most home, farm and workshop uses, easy-to-start machines call for *split-phase* motors; hard-to-start machines require *capacitor-start* motors.

Split-phase motors have only moderate starting torque and are built with ratings up to $\frac{1}{2}$ hp. Two windings, start and run, are energized at first. At about 80 percent of operating speed, a centrifugal switch cuts the start winding out of the circuit.

Capacitor-start motors, on the other hand, deliver two to three times the starting torque for the same amount of current. These are made with ratings from $\frac{1}{8}$ to 3 hp. Since capacitor-start motors cost from 25 to 50 percent more than split-phase motors of like power, split-phase

is the logical choice when the starting load is light (as on fans and blowers), or where the load is applied after the motor reaches full operating speed (drill press).

Both types use a single-phase power supply and, combined, make up about 90 percent of the motors in the U.S. Polyphase (usually three-phase) motors constitute the balance and are designed for continuous heavy-duty work. Because of the three-phase power requirement, however, polyphase motors are not often found in home workshops.

Most single-phase motors run at full load speeds of either 1725 or 3450 rpm. The faster motor is frequently the smaller of the two, and has a lower price per hp. When possible, this is the type to use since its speed can be reduced by a 6:1 belt-and-pulley combination.

With regard to voltage, a look at the motor's nameplate will tell you whether its rating corresponds to your power supply, which likely is 115 v.a.c., 60 cycle. The dual-voltage (115/230-v.), capacitor-start motors are available with ratings beginning at $\frac{1}{8}$ hp, while split-phase motors are rated at $\frac{1}{8}$ hp through $\frac{1}{2}$ hp. ★★

A Sure Way to Perk Up Tired Dehumidifiers



SURE CURE FOR INEFFICIENT UNIT is a scrubdown with stiff wire brush, hot soapy solution. Be sure that power is off and don't wet electric controls

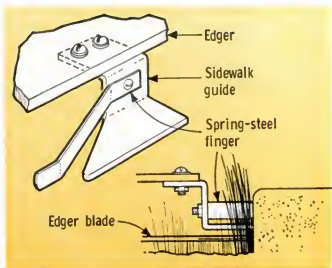
IF YOU'VE NOTICED that your shop dehumidifier doesn't seem to be operating as well as it used to, chances are a few minutes of your time can restore it to top-notch condition.

The most common cause of inefficiency is a combined accumulation of dust and moisture, especially if it forms a layer over the coils. Such a layer affects the heat transfer of the coils and greatly reduces overall performance.

The remedy calls for stiff brushing and washing with a solution of hot water and a heavily-ammoniated detergent. While you won't be able to brush the finned area behind the coils, nevertheless you can get it fairly clean by using an old syringe to squirt the hot solution at the otherwise inaccessible area.

After you rinse, dry and reassemble the unit, performance will be noticeably improved. Where several days were previously needed to fill the dehumidifier pan or bucket, it will almost fill every day after it's cleaned.—James F. Fish

A Finger On Your Edger Gives Neat Trim



THE BIG TROUBLE with rotary edge trimmers, especially when you want a really close trim, is that the blade can't reach the grass growing next to a walk, curb or foundation. To do so would mean a shower of sparks and a damaged cutter.

The answer is a spring finger added to the side of the trimmer to angle the grass away from the walk or curb, and guide it into the path of the cutting blade.

A section of hacksaw blade is a good material to use as the finger. First secure it in a vise and bend it to the shape shown in the drawings above. The easiest way to fasten the blade to the body of the trimmer is to first drill and countersink a hole through the steel flat. Then touch the tip of a welding rod into the countersunk hole and against the blade. Don't try to do without the countersinking or you'll be welding the edges of the hole.

If you find that your trimmer has a hardened guide, however, you can drill and tap a mounting hole for the blade. Just heat the hardened guide with a por-



STEEL FINGER guides grass away from sidewalks or curbs and pulls it into the trimmer's cutting blade

pane torch for a few minutes, concentrating the flame in the area of the hole to be drilled, and then allow the piece to cool gradually. Then drill and tap the mounting hole. Finally, retemper the piece by heating it again, then dousing it in a bucket of water. Use this same process on the length of hacksaw blade if you find it too difficult to bend cold.

—William G. Waggoner

Stowing Fishing Rods

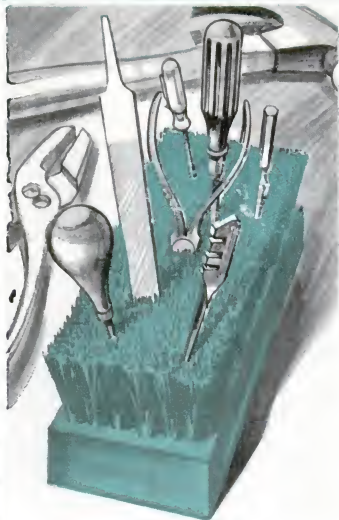
KEEP YOUR ROD from bouncing around your camper or trailer by "pinning" it to the ceiling of the cabin. All you'll need are two wooden clothespins, two 2-in. lengths of $\frac{3}{4}$ -in. dowel and two No. 8 woodscrews, 2½-in. long. Drill a countersunk hole through half of the disassembled pins, then drill through the dowels. Tighten the screws through pin halves, dowels and into ceiling stringers. Then reassemble pins and snap in the rod.—*R. Lewis*



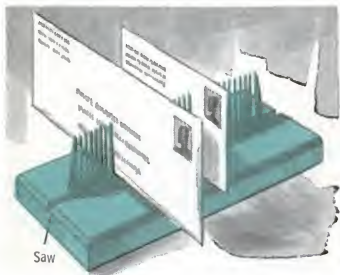
Solving home problems



MOST EFFICIENT WAY to use a star drill is to clamp it in vise-grip pliers. This eliminates the risk of accidentally hitting your hand and also gives you added leverage, making it easier to rotate the drill



TO HOLD SMALL TOOLS while working on a project, just place a large scrub brush on your bench with the bristles up. Pake the ends of the tools down between stiff bristles and they'll always be handy



MODERN LETTER RACK is a simple one-hour project. Just cut a shallow saw kerf down the middle of a block of hardwood to hold a coarse-toothed steel comb, then finish the block and cement comb in slot



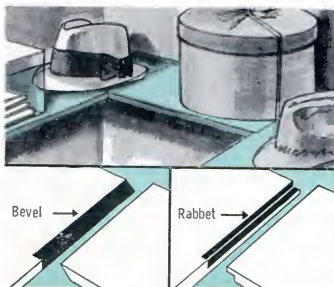
IT'S IMPOSSIBLE to eliminate the mess involved in removing paint. However, sawdust sprinkled over the surface before the remover has set up will stick to the old paint and make the sludge easier to remove



TO KEEP A GOOD EDGE on shop knives and other workshop tools, cement a strip of fine emery cloth to an old leather belt and hang it on your workbench. Use the other side of the belt to strop the knives.

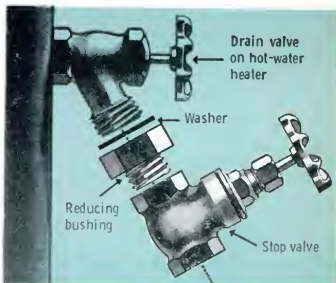


CAMPERS WILL FIND 35-mm film cans handy for carrying many things. Being watertight, they're fine for matches. You can also glue foil over opening and punch holes to make salt and pepper shakers.



NEATEST METHOD of supporting a shelf at the end of a closet is to half-lap or angle-cut the ends to fit corresponding cuts in the side shelves. Joints may be secured with glue and small nails or screws.

JUNE 1968



PIGGYBACK VALVE added to the leaky drain valve of a furnace or water heater lets you stop the leak without having to empty the tank. Use a reducing bushing and pipe-joint compound to mount stop valve.

WHAT MAKES A GOOD NAIL GOOD?

About 67,000 nails go into the construction of an average house. Only 20 are used for a knick-knack box. Pick the wrong type of nail and the house may fall apart—so could the simple box

By JAMES P. SCHENLEY

Technical Art by Roger Chapin

NAILS are much like medicines—they must be chosen carefully if they're to cure or prevent a specific problem. For, among the hundreds of nail types available at any hardware store, only one size and shape is *the best* to use for a particular job. Other nails may do the job, but the right one will do it better.

For general carpentry and construction work, your choice should be one of the general-purpose nails—common, box, casing and finishing.

Common and box nails have flat heads and diamond points, although the heads of box nails are somewhat larger than those of common nails. The major difference between the two lies in their diameters, for although all nails of a particular size classification are always the same length, their diameters will vary from one type to another. For example, a 10-penny (10d) common nail has a 9-ga. diameter (.1483 in.), while a 10d box nail has a 10½-ga. diameter (.1277 in.). Therefore, if you're using a common nail that tends to split the wood, switching to box nails of an identical penny size often will avoid such splitting.

As you can see in the chart on the opposite page, this same difference in diameter also applies between casing and finishing nails of the same size. While both types have diamond points, finishing nails have brad heads for use where countersinking is not important, whereas casing nails have heads specially designed for countersinking.

One factor common to these four types of nails, however, is their identical length vs. penny size. Thus, a 10d nail is always 3 in. long, a 40d nail is always 5 in. long, and so on, regardless of whether it's a common, box, casing or finishing nail. For

this reason, you can order nails either by penny size or by length, although penny size is the more common of the two terms. As a general rule, you can expect to receive the following number of common nails per pound per penny size:

2d—847	8d—101	20d—30
3d—543	10d—66	30d—23
4d—296	12d—66	40d—17
6d—167	16d—47	60d—11

Special-purpose nails, however, form an entirely different category—a large category that often appears confusing because some special-purpose nails are available in a variety of point configurations to compensate for the hardness of various woods. Standard flooring nails, for example, are made in 8d (2½-in.) lengths, and are designed for softwood flooring like pine and fir. They have ordinary diamond points and are made of 10-ga. steel.

Used with *hardwood* flooring, however, these standard flooring nails will either split the wood or bend. For this reason, a special hardwood flooring nail should be used. It, too, is 8d, but it has a blunt diamond point which shears through the hardwood fibers. Because the point's better cutting action allows the nail to pass more freely and without bending, the diameter of the nail shank can be reduced to avoid splitting the wood. Thus, this type of hardwood nail is made of 11½-ga. steel.

Another type of diamond point is the long one that tapers to a sharp angle and is easier to drive than ordinary diamond-point nails. Drywall nails are typical long-diamond-pointed fasteners. The longer point allows clean and easy penetration of the drywall.

Needle points are similar to the long diamond points, except that they have a

TYPES OF POINTS



BLUNT
DIAMOND



REGULAR
DIAMOND



LONG
DIAMOND



CHISEL (WEDGE)
POINT



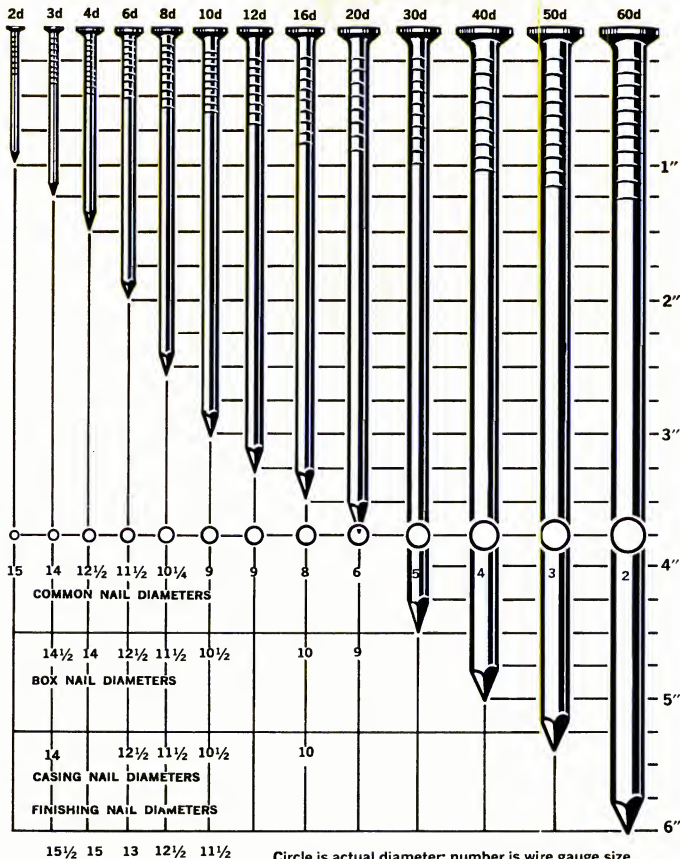
SHORT
NEEDLE

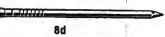
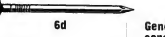
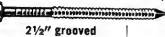
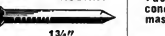
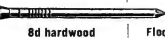


LONG
NEEDLE

PENNY SIZE

NAIL GUIDE CHART, TYPE AND SIZE



NAIL	PURPOSE	TYPE OF POINT	TYPE OF HEAD	SPECIAL FEATURES	*STANDARD SIZES
BOX  8d  2 1/2" grooved	General construction, carpentry	Diamond	Large flat	Available with grooved shank	3d (14 1/2), 4d & 5d (14), 6d & 7d (12 1/2), 8d (11 1/2), 10d (10 1/2), 16d (10), 20d (9)
BRICK SIDING  3/4"	Installation of brick siding	Diamond	Checkered flat	Galvanized and painted to match siding. Available in red, black, buff	3/4" (13), 7/8" (13), 1" (13), 1 1/4" (13), 1 1/2" (13), 1 3/4" (13), 2" (12 1/2), 2 1/2" (11 1/2)
CASING  8d	Fine finish work	Diamond	Deep countersunk		4d (14), 6d (12 1/2), 8d (11 1/2), 10d (10 1/2), 16d (10)
COMMON  6d  2 1/2" grooved	General construction, carpentry	Diamond	Flat	Available with grooved shank	2d (15), 3d (14), 4d & 5d (12 1/2), 6d & 7d (11 1/2), 8d & 9d (10 1/2), 10d & 12d (9), 16d (8), 20d (16), 30d (5), 40d (4), 50d (3), 60d (2)
CONCRETE AND MASONRY  1 3/4"  2 1/2" fluted	Fastening into concrete, masonry	Diamond	Flat or square	Some with fluted shanks	Available in fractional lengths of 1/2" to 3" and in various gauge sizes
FLOORING  8d hardwood  2 1/2" hardwood, grooved	Floor construction	Diamond or blunt	Deep countersunk	Available in grooved shank to eliminate squeaks. These have flat countersunk heads and blunt points. Sizes: 6d, 7d, 8d—all 11 1/2 ga.	Standard flooring nail: 8d (10). Hardwood flooring nail: 8d (11 1/2)

circular, rather than an angular, cross-section. An example is the fiberboard nail, which is ideal for fast, secure nailing of fiberboard.

Chisel or wedge points allow nails to deeply penetrate and firmly anchor in wood. Gutter spikes for nailing aluminum and galvanized gutters come with chisel points.

Special heads and materials

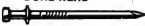
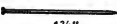
Nails will also differ in the size and shape of their heads. Dual-headed nails, for example, make it possible to construct sturdy concrete forms. The lower head anchors the wood, while the upper head protrudes for easy removal of the nail,

without damaging the reusable wood form.

Roofing nails have a broad flat head to keep water from seeping under the head and through the roof. One variation is the umbrella head, which also prevents leaks.

Other special nailheads include those stamped with numbers. These are commonly used to identify similar or interlocking objects, such as storm windows and their respective window sash.

Nails also vary as to the materials from which they're made. Common materials include steel, aluminum, copper and brass. Nails made of metals other than ordinary steel are designed for fastening objects made of the same metal. This matching greatly reduces the corrosive action that

NAIL	PURPOSE	TYPE OF POINT	TYPE OF HEAD	SPECIAL FEATURES	*STANDARD SIZES
WALLBOARD  4d  1 1/2" grooved	Installing gypsum wallboard	Diamond	Flat	Smooth or grooved shank. Available also with coating for extra holding power	Smooth shank: 4d (14), 5d (13 1/2), 6d (13), Grooved shank: 1 1/4", 1 3/8", 1 1/2"—all 12 1/2 ga.
DUAL-HEAD  6d	Temporary lumber construction	Diamond	Dual		6d (11 1/2), 8d (10 1/4), 10d (9), 16d (8), 20d (6)
FINISHING  8d	General construction, carpentry	Diamond	Brad		3d (15 1/2), 4d (15), 6d (13), 8d (12 1/2), 10d (11 1/2)
INSULATION BUILDING BOARD  1 3/4"	Installing insulation board	Needle	Flat	Available in barbed shank with diamond point	1 1/4" and 1 3/4" (17), 2" (11)
ROOFING  1" Smooth  1" Barbed	Roofing installation	Diamond	Large flat or umbrella	Available with grooved or barbed shanks and coated	Fractionally from 7/8" to 2", usually in 11 ga.
FIBERBOARD  1 1/4"	Fast nailing of soft materials	Needle	Flat	Available bright, galvanized or cadmium-plated	1", 1 1/8", 1 1/4", 1 3/8", 1 1/2", 1 5/8", 1 3/4"—all 17 ga.
UNDERLAY  1 1/4"	Installing floor underlayment	Diamond	Flat	Available with grooved shank	1 1/4" (14)
WOOD SHINGLE  3 1/2d	Installing shingles	Diamond	Flat	Available with grooved or barbed shank	3d (13), 3 1/2d (12 1/2), 4d (12)

*Figures in parentheses are gauge numbers

occurs when different metals are placed in contact with each other. Aluminum nails, as an example, should be used to secure aluminum gutters to aluminum siding.

Many nails, especially those for outdoor use, often are given a metal coating (such as zinc or brass) to help prevent rust and corrosion. Zinc-coated asbestos siding nails, for instance, help to offset the normal deterioration of the nail.

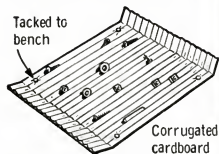
Other types of nails are coated with glue. When the nail is driven into the wood, the heat of passage melts the glue, which then hardens to hold the nail fast. This type of nail, however, is difficult to pull once set, so it should be used only in permanent installations.

Certain roofing nails are given a lead coating that prevents leaks by filling the hole as the nail is driven. As with a glue-coated nail, removal is difficult.

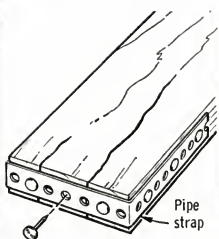
While the shanks of most nails are usually smooth, nails with helical, barbed or annular shanks should be used when extra holding power is needed. These grooved nails cost approximately twice the amount charged for regular nails, but they provide up to ten times more holding power in return. Consider them for jobs such as nailing drywall to studs (they won't pop out as readily as will straight-shank nails), or nailing shingle or shake siding to a house (they'll hold the siding fast against heavy winds and storms). ★★ ★

HINTS

FROM READERS



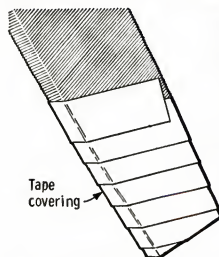
WORKBENCH TRAY keeps small parts in order when you dismantle motors or other mechanisms. Just cut a piece of corrugated cardboard and bend the ends up, as shown above. Use tacks at all corners to hold the tray in place



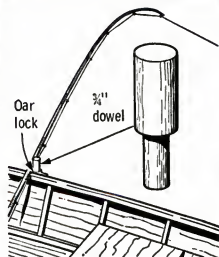
REINFORCE ENDS of scaffolding planks with perforated steel pipe strapping and they'll be less likely to split. If a plank has begun to split, clamp it together before you strap the end. Use 1-in. roofing nails to secure the strap



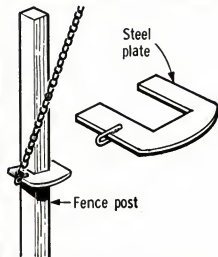
SAFETY CHAIN for your extension ladder loops around tree trunk to prevent ladder from slipping during pruning work. Drive hooks into the sides of upper section of ladder and slip chain links over them once the ladder is in position



PROTECT FINGERS during a long filing job by wrapping the tip of the file with masking tape. This will not only save wear and tear on your fingers, but also let you take a firmer grip on the file and put more power in each stroke

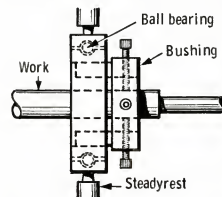


ROD RETAINER PIN to prevent your fishing rod from sliding along the gunnel when trolling is just a short length of $\frac{3}{4}$ -in. dowel with the bottom portion whittled down to fit into the oarlock. Brace butt of the rod against your tackle box

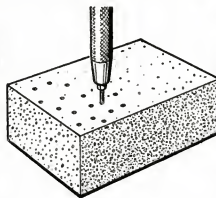


POST-PULLING HOOK for use with hydraulic hoist on a tractor is much more efficient than wrapping a chain around each post. Designed for pulling square posts, it's made from $\frac{3}{4}$ -in. steel plate with pull chain welded to one side

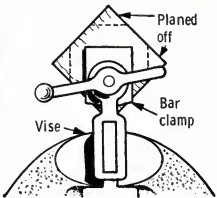
A STEADY REST INSERT permits high-speed turning of small-diameter shafts. It's a ball bearing with a press-fit bushing in the bore. Tap the bushing for four opposed screws to center the work. Center the insert in the steady rest



WIPING BLOCK for draftsmen will remove those tiny flakes of graphite from a freshly sharpened pencil and eliminate the risk of accidentally smudging your drawing. Cut a small block of Styrofoam and mount near pencil sharpener



BETTER WAY of holding a turning square so you can knock off the corners with a plane is to mount it in a bar clamp and then lock the clamp in your vise. This holds the turning square securely in a position which is ideal for planing



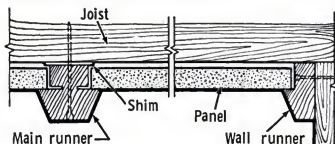
One-Step Redwood Grid Makes Ceiling Installation a Breeze

A NEAT SOLUTION to ceiling remodeling problems, Simpson Timber's new redwood grid system enables you to finish off complete ceilings in just a few hours.

The secret to its foolproof installation lies with the wooden runners that make it possible to secure the runners directly to the joists. Thus, no furring or suspension system is necessary, although shims may be required to level any uneven spots.

Begin the installation by nailing a wall runner to a long wall, followed by the first main runner spaced 2 ft. from the wall. Then lay in the first 2x2 or 2x4-ft. decorative panel and slide in a 2-ft. cross runner. When the first row is completed, add the next main runner and slide in panels and cross runners, continuing until the ceiling is complete.

For prices and specifications on the grid system and panels, check your local dealer handling Simpson products. ★ ★ ★



MAIN RUNNERS ARE NAILED directly to joists. Use the cross runners to help determine the exact spacing



SLIDE IN DECORATIVE PANELS, either 2x2 or 2x4-ft., then frame them by sliding in mitered cross runners



PORTABLE ELECTRIC MIST BLOWER is a hand sprayer that lets homeowners and gardeners gain efficient control of mosquitoes and other biting insects. Gardeners can apply plant health chemicals quickly with professional results. A flexible 24-inch hose sprays trees and hard-to-reach insect breeding areas. Unit of about 11 pounds sells for \$74.95. Root-Lowell Corp., Lowell, Mich.

THROW-AWAY FRYING PAN—a holder and an aluminum foil pan—is ideal for frying eggs, hamburgers or potatoes over an open fire or campstove. A major advantage is economical disposal of the pan after use, ending cleanup chores. An 8-inch holder with five pans costs \$2.75 postpaid; a 12-inch holder with four pans, \$3.98. From K-P Industries, 21401 Kenyon Dr., Cleveland.



EXCITING NEW PRODUCTS

By CAROL SCHULTZ



GUNSTOCK COMPASS is designed to be inset into a gun or longbow; a special insetting tool is included for easy installation. Compass operation is simple and the need for an area map is eliminated. Priced at \$6.95 from the Poly-choke Co., Inc., Box 296, Hartford, Conn.

DRAFT-BEER TAP is intended to fit a standard gallon beer can, gives the flavor of real draft beer. Tapped can stored under constant refrigeration will retain full beer flavor for weeks. Priced under \$5 by Bridgeport Brass Co., 30 Grand St., Bridgeport, Conn.





TELEPHONE MEMO BOARD has a writing surface that wipes clean with a damp cloth. The board, 15 inches wide by 13 inches high, holds a marker and note pad. Available in several colors, \$2.98. By Dri Mark Products, Inc., 158 S. 12th Ave., Mount Vernon, N.Y.

ELECTRIC BARBECUE made for outdoor use, plugs into 120-v., 20-amp., 3-wire receptacle to let electric heating element and ceramic briquets cook your food. Chromed grid is 14½ by 22 inches. Model shown is \$149.95. Portable Kitchens, Box 3707, Little Rock, Ark.

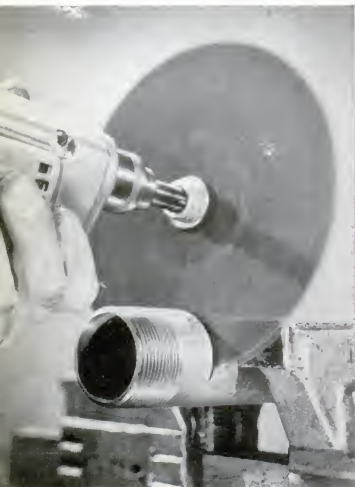


STAR FINDER, patterned after the classic armillary sphere developed in 300 B.C., will enable you to identify and locate stars quickly without use of mathematical calculations. It comes with a world star chart and a complete manual explaining how the instrument may also be used as an astronomical computer, a sun or moon dial and a solar compass. Sells for under \$15. Made by Skil Craft Playthings, Inc. 325 W. Huron, Chicago, Ill.

PORTABLE LIGHTS offer a good means of instant illumination anywhere. "Thro-Lites," made of polyethylene, are almost indestructible. They are floatable and self-righting when thrown. Two styles are available: safety lights primarily designed for highway and water emergencies; party lights in decorator colors for home, patio and pool. Sets of three sell for \$4.99. Made by Nicholl Brothers, Inc., Kansas City, Mo.

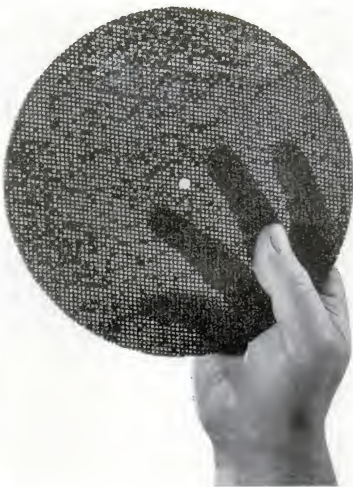
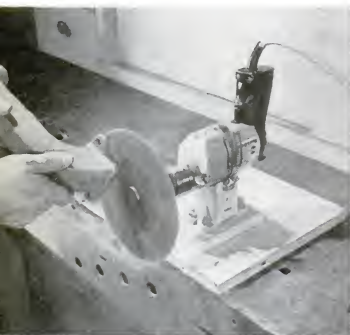


PM tests NEW SHATTERPROOF



HELD FREEHAND in a drill, the new abrasive disc cuts through thick metal like this iron pipe in a fraction of the time it would take with a hacksaw

SMOOTHING AND SHAPING METAL are easily done against the disc's side with the drill held rigid. A simple drill stand makes a good stationary setup



OPEN MESH CONSTRUCTION makes the disc flexible and shatterproof. It also keeps chips from clogging the abrasive and reducing the wheel's efficiency

MOUNTED IN A BENCH SAW, the disc slices almost unbelievably through a heavy 3x3-in. steel fire-place lintel. Trick is to keep feed pressure gentle



CUTOFF WHEEL

By SHELDON M. GALLAGER

This handy drill accessory cuts metal, brick, stone—you name it. And it's so safe you can use it without a guard

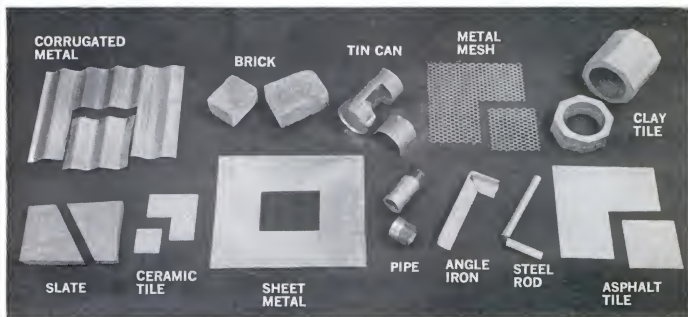
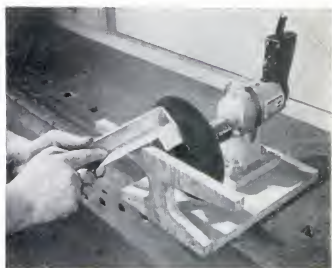
IF SOMEONE SAID you could slice through 2-in. pipe with an abrasive wheel held freehand in an electric drill, you'd probably think he was putting you on. We did, too—at first. The fact is, the new abrasive wheel shown here will do this and just about any other rugged cutting job around the home or shop. It gleefully chomps through brick, slate, tile, tough composition boards and metals of all kinds. A few of the many materials it will handle are shown in the bottom photo.

The disc, just introduced by Coastal Abrasive, represents a completely new concept in cutoff wheels. Unlike the conventional rigid type, it consists of resilient nylon mesh impregnated with silicon carbide grit. The nylon core makes the disc flexible and shatterproof. Because it can't break, it can be safely used without a guard in an electric drill, flexible shaft, even a table saw.

As the abrasive is gradually worn away

(Please turn to page 183)

TWO HANDY JIGS you can make yourself are shown below. Accessory table at left helps you make precision cuts, such as notching out the corner of this ceramic tile. Simple T-shaped rest at right steadies work for freehand smoothing and shaping. Both jigs are made of $\frac{3}{4}$ -in. plywood plus a commercial drill stand



The Knack of

KNURLING

By WALTER E. BURTON



LUBRICATING OIL applied to both knurls and work surface produces clean-cut knurling

SOMEHOW, it always seems that metal-turned projects are twice as handsome after they're knurled. Yet, aside from improving the appearance of a tool, knurling can serve other important uses.

The foremost advantage of a knurled tool is the good grip you achieve. Even when coated with an oil slick, a knurled tool can be wielded with ease and safety.

There also are a few mechanical functions that knurling can perform, such as slightly increasing the outer diameter of a rod, or reducing the inner diameter of a tube or cylinder. Exactly how these unusual jobs are completed will be explained later.

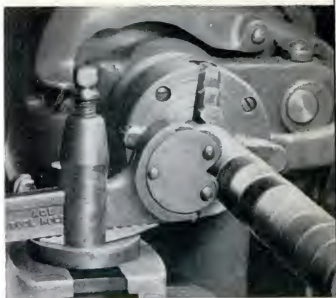
Ordinarily, knurling is accomplished by forcing one or two ridged rollers against a revolving piece of work. The sharp ridges, or teeth, may run either straight or diagonally across the roller surface. On a pair of diagonal knurls, the ridges run in opposite directions so they will produce crossed helical grooves or a diamond pattern on the work. Such a pair of rollers is commonly used for most home-workshop metal-turning and usually is mounted in a rocking head that's self-adjusting for even pressure. Another useful type of knurler has only one roller; you can make such a tool if you cannot find one commercially available.

Knurling rollers are obtainable for use in custom-made tools and for replacing worn rollers. They come in various diameters, such as the $\frac{5}{8}$ and $\frac{3}{4}$ in. sizes shown in the photos, and with different numbers of teeth per inch (pitch). In general, knurls are classified as coarse (14 pitch), medium (21 pitch) and fine (32 pitch). For most of your requirements, a pair of medium-pitch diagonal knurls in a conventional two-roller holder, like that shown, is sufficient.

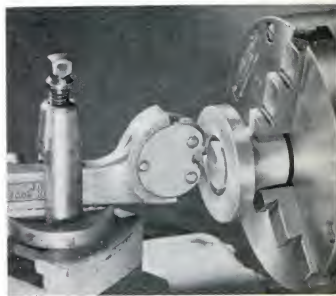
Mounting the work: When its length is adequate, a piece of work can be mounted either between centers, or with one end in a chuck and the other end supported by the tailstock. To resist crosswise pressure applied by the rollers, the center holes in the workpiece should be fairly deep and well-lubricated, preferably with a graphite grease.

If a chuck is used, the workpiece end should rest against the chuck body or a stop positioned in the headstock-spindle hole. Be sure the tailstock and its spindle are locked securely to resist pressure.

Starting the cut: Whether or not a knurl will track properly is usually determined during the first revolution of the workpiece. Position the knurler so one-half of the roller width overhangs the tailstock end of the section to be



TWO-ROLLER KNURLER can be used as a single roller tool simply by positioning it so that only the lower roller contacts the work



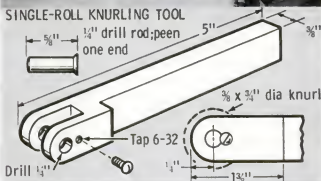
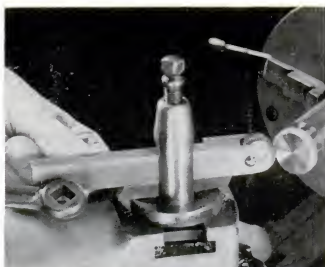
FACE KNURLING with a two-wheel knurler normally will produce diamond pattern that's dependent upon the radius of knurled area



SPRINGY ALUMINUM ROD is held against knurls by a follower rest bolted to lathe carriage. In such cases, use plenty of oil



TWO-ROLLER KNURLER (above) can also be inverted so that only one roller contacts the work (in this case, a small thumb screw). A diagonal pattern results. A straight knurl can be used on the bevel of a knob or rod (above right). Here, the circumference of the brass knob has been knurled in a diamond pattern. Details of a one-roller knurler (right) can be used to make your own. The rollers are standard sizes



knurled. Bring the rollers squarely against the work. (When knurling some of the harder metals, a knurler is sometimes swung at an angle.)

Rock the workpiece back and forth while using the cross-feed screw to press the knurls against the surface. In this way, force the knurl against the work to make a cut about 0.045 to 0.050 in. deep. Then turn the workpiece through a full revolution (by hand) and continue turning into the second revolution while checking that the teeth track in the cuts they made during the first turn. If they do, the knurl should continue to track properly and you can proceed under power. Some operators back off the cross-feed screw a bit, to reduce pressure, before starting the longitudinal feed.

At first, try running the lathe at its slowest speed, using the back gears. With experience, you'll find the best knurling speeds for your particular lathe. As a general rule, however, 1-in. steel rod can be knurled at about 160 rpm, or 40 surface feet per minute. Apply plenty of lubricating oil or cutting fluid to both the knurls and the surface being knurled. Oil should also be applied to the steady-rests or follower-rests whenever they're in use.

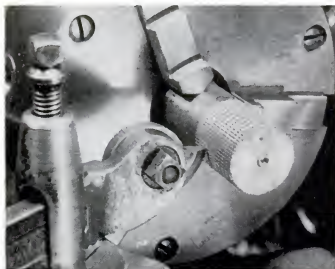
Initially, try using a feed of 0.025 to 0.050 in. per revolution, applying the slower feed for the harder metals. On soft metals, such as aluminum, a full diamond pattern can be produced with a single pass. Commonly, however, several passes will be required, each with a slight inward

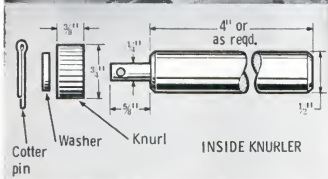
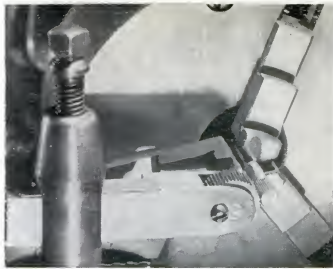
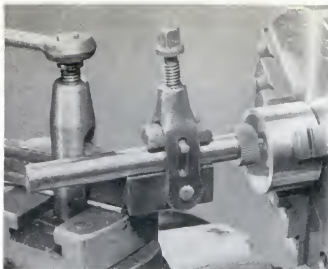
movement of the knurler via the cross-feed screw.

Knurls can be moved back and forth along the work without jumping out of the pattern as long as they are pressed firmly against the work surface. Even when removed from the work, a knurler can often be repositioned (by hand) so the knurls will re-engage the indentations for proper tracking.

With a single-roller knurler, you can sometimes cure defective tracking by increasing the pressure on the cross-feed screw. The knurl will roll out the first off-pitch marks. This technique, however, is less likely to work when a two-roll

NOVEL PATTERN can be produced by threading rods that have been previously knurled in straight pattern





KNURLING INSIDE A CYLINDER is easy with a single roller tool (above left). Inside knurling can also be used to decrease the i.d. of a tube. Straight-knurl the end of a 1/4-in. rod (above) to increase its o.d. and make it fit tightly in a slightly oversize hole. Again, oil is essential. Details for a simple, single-roller knurling tube (left) will enable you to knurl inside cylinders using commercially available roller

knurler is being used to develop a diamond pattern. In this case, a fresh start in a pattern of sufficient depth will roll out the marks of false starts.

Although a full diamond or other pattern can be produced only by feeding the knurls inward enough to fully shape the ridges or domes, a partial knurl may be adequate. This is produced by cutting to less than full depth. Getting the knurls to track properly for a shallow pattern can be a bit tricky, however.

One solution is to start the knurling at the end of the area with considerable pressure and a deep cut until the rollers track properly, then ease back on the

cross-feed so the knurls will cut a partial pattern the rest of the way. Finally, the starting band produced by this method will have to be machined off. An alternative solution, however, is to start the knurl on a slight ridge, which will be machined down later.

Normally, knurled areas can be finished by polishing with a fine abrasive cloth or wire-brushing to remove chips. With partial knurling, the work can be filed to remove projecting burrs, leaving only the depressions made by the teeth of the knurler.

Soft materials, such as aluminum and brass, have a tendency to flake when knurled. The resulting chips should be wire-brushed from the work and knurl teeth whenever an accumulation becomes apparent.

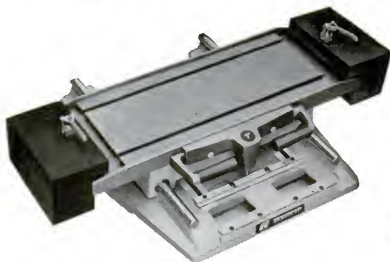
Increasing a diameter by straight knurling provides a way of obtaining a tight fit between two parts, such as a stud in a hole, or two tubular sections. With a stud or a rod, the portion to be inserted is machined to the size of the hole or slightly less and then knurled. If it is hardened, it cuts a series of splines as it is driven into the hole to produce a tight joint.

With a tube, however, knurling will produce only a decrease in the inner diameter unless the tube is fitted on a mandrel. This is especially true of thin-wall tubes where the knurling pressure would normally decrease the inner diameter much more than it would increase the outer diameter. ★★★

FLAT SURFACES can be knurled. Lock tool in chuck, work in milling vise. Feed with cross-feed screw



New Tools You Should Know About



Template-controlled mill-drill table

A new hand-operated, work-positioning table offers low-cost automation for your metal shop. With templates to control positioning and guidance, it permits you to use an ordinary drill press or milling machine for small



production runs involving straight milling, contour milling, drilling or any combination of these. The Mill-Drill Table can also be used for reaming, tapping, counterboring and any other operation requiring precision positioning. It's manufactured by Thompson Industries, Inc., Manhasset, N.Y. 11030.

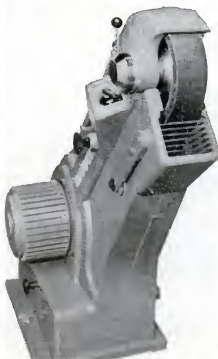


Two multi-speed sabre saws

New additions to Black & Decker's industrial line are two Model 982 sabre saws, one offering four speeds (\$100) and the other two (\$85). High speed is for general work, low for hard metals. Intermediate speeds match in-between needs.

Belt/Wheel grinder

The Diamant 225 has an 88-in. belt, and a 10-in. rubber wheel for both contact and flat grinding operations. Available from Technical Processors Inc., 415 Greenbay Rd., Wilmette, Ill.



T-handle hex keys

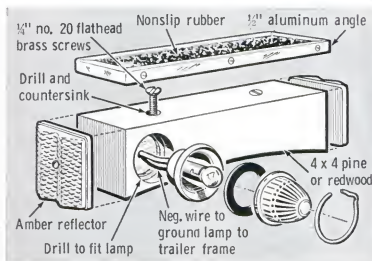
New T-handle hex keys are sold either separately or in sets of 10 popular sizes, complete with metal bench stand featuring an easy-to-read key fit chart. Designed to give high torque in tight spaces, they're from Ekland Tool and Mfg. Co., 2631 N. Western Ave., Chicago, Ill.



Make This Step-Light for Your Boat Trailer

A perennial problem with boat trailers is broken or corroded running lights. You can solve it, though, by making a pair of these simple trailer steps having built-in side-lights. The mounting offers maximum protection from accidental breakage and locates the light where it is almost impossible to submerge.

If available, use 4x4 redwood for the block, since this is both easy to work and naturally resistant to rot. The step shown here has a vinyl rubber matting on top, but any other nonskid material could be used as a step surface. Don't forget to ground the light to the trailer frame. Also, in order to comply with most state highway regulations, be sure to mount the step so that the tip of the light extends just beyond the edge of the trailer.—Patrick Perrett



Stop block provides added safety when mounting dado head

The teeth on a dado head are razor sharp, and the farther you keep your fingers away from them, the better. When mounting or removing a dado head, though, something has to hold the head while you tighten or loosen the arbor nut. The best idea is to cut a bevel on one end of a scrap piece of 1-in. stock so you can shove it between the teeth. This will prove sufficient leverage to hold the head while turning the nut. Since the block will be needed every time you use the dado head, drill a hole in one end and hang it where you store the head.



BIG HANDFUL OF POWER IS SMALLEST YET

Whir your way through wood, plastics and most metals with this new type of hand grinder. Tiny though it is, it packs a potent punch



By JOHN BURROUGHS

YOU CAN'T ALWAYS JUDGE a power tool by its casing—especially if it's the newest and smallest hand grinder from Dremel.

Weighing a scant 7 oz., the 260 Moto-Tool winds up at close to 30,000 rpm and belts out an amazing 16 oz./in. of torque. *Constant torque*, that is—enough to make the new tool all but stallproof under normal use with ordinary burrs and grinding points.

The surprising performance of this tool results from its radically different motor, which is far from being a slightly improved universal-type motor like that in other portable power tools.

The conventional field coils inherent in universal motors are missing. Taking their place is a pair of *field poles* made of barium ferrite, a space-age material with a demagnetization resistance higher than that of any other material. Thus, the new motor is called a P.M. (permanent magnet) motor because the field flux is supplied by the magnets, and not by a separate coil.

The advantages of P.M. motors include a high peak efficiency, more power per unit size and a relatively flat *speed-versus-torque* curve, especially when compared to that for a series-wound motor. Because of this flat curve, light-duty jobs dependent upon high speed are accomplished as easily as those heavy-duty tasks requiring high torque. Even if

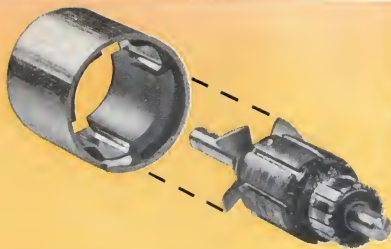
the tool is loaded enough to decrease the speed, the torque output remains the same.

An additional advantage is the virtual elimination of field problems. Once a P.M. field of barium ferrite is energized, it is, for all practical purposes, permanent. Actually, there is no real "energy" that can dissipate. The energization of a P.M. field is accomplished by realigning the molecular structure of the material so that all magnetic fields are running in the same direction. The only possible way to demagnetize the field would be to run a greater flux in the opposite direction.

Since the permanent magnets are given a fixed polarity, alternating current passing through the armature would not cause the armature to turn. Thus, because the P.M. type of motor is really a shunt motor, or a d.c. device, a rectifier circuit is incorporated to transform household a.c. to the required d.c. In the Moto-Tool, the rectifier is a full-wave bridge type placed on the switched side of the on-off switch. The rectified d.c. is then fed to the armature through a commutator and brushes.

For this reason, the tool must be used *only* with an a.c. source. Solid-state speed controls cannot be used to vary the speed of the tool. The pulsating d.c. output of a speed-control device will not power the tool properly and may, in fact, cause damage to the rectifier diodes.

The armature in the new motor has



ARMATURE SLIPS IN CYLINDRICAL HOUSING (left) containing two permanent magnets of barium ferrite. Tiny switch (right) connects power from an a.c. source to the rectifier bridge. Tool cannot be used on d.c.

eight poles, compared to five poles in the universal motor formerly used in Dremel's hand grinders. To couple the rectified power to the armature, 16 commutator bars and improved brushes are used, and offer the side benefit of reducing the TV interference that is normally produced by the arcing between brushes and commutators.

Another improvement over Dremel's old line of grinders is the addition of a cooling fan blade to the armature shaft. Even when loaded for an extended period, the new tool resists overheating.

Model 260 draws half an amp. and fea-

tures oilless bearings. Two bigger brothers, the 11-oz. Model 270 and the 280, with ball bearings, are fitted with the same type of motor, but they will draw .9 amp. in operation.

Each of the three models has a shock-proof Lexan casing and all are available with collets for $\frac{1}{32}$, $\frac{1}{16}$, $\frac{3}{32}$, and $\frac{1}{8}$ in. tool shafts. Prices begin at \$22.95 (Model 260), and range upward to \$39.95 (Model 280); they do not include the bits and wheels.

For a 160-page book on what you can do with a hand grinder, send \$1 to Dremel Mfg. Co., Racine, Wis. 53401. ★★ ★

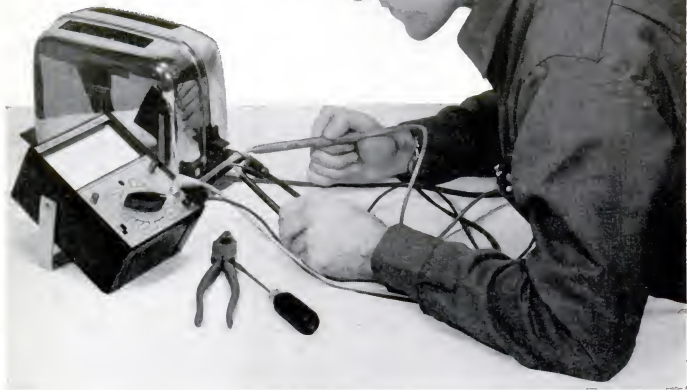
DRILL-PRESS ACCESSORY has knob that raises and lowers the table, not the hand grinder

UNIVERSAL STAND of cast iron adjusts to hold tool in any position, leaves both hands free

SHAPING ATTACHMENT mounts on neck of the tool, is adjusted to regulate the depth of the cut



How to pick The Right Test Meter For the Job



TOASTER HEATING ELEMENT is checked with ohmmeter scale of Triplet Model 600 transistORIZED volt-ohmmeter

Circuit continuity or presence of voltage is easily checked with a tester, but when you have to measure voltage, current or resistance, you need a meter

By WALTER G. SALM

MODERN HOME APPLIANCES aren't very convenient if they won't work when you need them. Trying to keep your worksaving appliances and all the other plug-in paraphernalia of a home ship-shape, you soon realize you can't get very far without an electrical measuring instrument of one type or other.

The most elementary instrument is an electrical continuity tester. Nothing more than a source of voltage and a light bulb, it simply measures electrical continuity from one point to another in a wire or appliance. Another basic tool is the neon tester. When the neon lamp glows, the tester, connected across a 115-v.a.c. household circuit, reveals the presence of

voltage. These are available at electrical supply stores.

But when it comes to checking something more complex than electrical continuity or the mere presence of line voltage, you'll need a test meter of some kind. Meters can generally be classified into two categories: the a.c. vacuum-tube voltmeter (v.t.v.m.), and the battery-operated volt-ohm-milliammeter (v.o.m.).

The typical v.o.m. measures a.c. and d.c. voltage, current and resistance in several ranges, or steps. The abbreviation "v.o.m.," incidentally, also refers to meters that do not have the current-measuring capacity. Since "v.o.m." may mean only "volt-ohmmeter," always check an instrument to be



APPLIANCE CURRENT DRAW is checked without breaking circuit using snap-jawed Amprobe meter

sure which type it is. The v.t.v.m. measures a.c. and d.c. voltage and resistance. When you know how each kind of meter does its job, you'll be better able to tell which is best suited to your needs.

The basic v.o.m. or v.t.v.m. consists of a jeweled-pivot meter movement that reads a very minute amount of electrical current. To measure resistance, the meter uses an internal battery to send a very small amount of measured electrical current through a calibrated resistor and the unknown resistance. The ohmmeter usually has a front-panel knob for readjusting the zero point. This adjustment cor-



ELECTRONIC COMPONENTS, such as diode here, can be removed from circuit, checked with meter

rects for any drop in battery voltage caused by the battery's aging. Even the a.c.-operated v.t.v.m. uses an internal battery to measure resistances, since this is the most accurate method.

You'll need an ohmmeter to service certain kinds of appliances, such as toasters, coffeemakers, irons, and so on. The heating element in these devices has a specific resistance that may be high enough to prevent the bulb in a continuity tester from lighting. In such cases you have to *measure* the resistance and you'll need an ohmmeter. The ohmmeter scale of a battery-operated v.o.m. or a v.t.v.m. can be used.

The resistance of the nichrome heating element in appliances may be anywhere from 20 to several hundred ohms. If you read any resistance up to 100 ohms or so, the heating element is probably all right. If you read infinite resistance, then the element is open (or the switch isn't on) and should be repaired or replaced. The easiest way to do this is to check resistance between both sides of the a.c. line at the plug with the plug out and the switch turned on. Also check resistance from each plug pin to the metal exterior of the appliance. Low or zero resistance means there's an internal short that can cause a dangerous shock.

A voltmeter, on the other hand, uses a known-value resistor in series with the meter itself. The value of this resistor adjusts the amount of meter deflection and the scale sensitivity of the meter when you turn the control selector switch. Flipping this switch substitutes one resistor for another. In making voltage measurements, the probes are placed across the voltage source or across the two points at which the voltage is to be measured. This places the meter circuit in parallel with the voltage load.

The line voltage available at your wall outlet, incidentally, is not always the same. There are peak hours of electrical use, and during those hours the power company throws in everything that it has available to meet the demand. Very often it's still not enough. Instead of 117 v., you may have only 107 v., or even less. At other times, especially late at night, you may have too much voltage. This kind of fluctuation can be wearing on appliances, light bulbs and entertainment equipment. Too low a voltage can keep appliances



ASSORTMENT OF VARIOUS METERS (from left): Lafayette v.o.m., \$17; RCA v.t.v.m., \$58 kit, \$84 wired; Heathkit MM-1 v.o.m., \$30; Triplett solid-state v.o.m., \$78; EICO 232 v.t.v.m., \$30 kit, \$50 wired; Amprobe, \$22.50

from operating at optimum efficiency. If you suspect that you have widely fluctuating voltages, check at various times during the day with your v.o.m. or v.t.v.m. set on its a.c. scale.

When taking current measurements, the meter must be in series with the circuit being measured. This means breaking the circuit at some convenient point and attaching the meter probes to the test points that this break creates. The entire current under test doesn't flow through the meter movement itself; this would probably ruin the meter. All that's needed is a very small fraction of test current, and the rest goes through a "shunt" resistance. This shunt is designed to handle large current loads and to prevent the meter from burning out from excessive current. An additional resistor may be in parallel or in series with the meter to act as a range-selecting resistor.

Breaking the circuit to make current measurements is not always the easiest thing to do, especially when house current is involved. An inductive method of measuring current flow is possible, however. An inductive-type ammeter has an alligator-like jaw that opens up and snaps around the current-carrying wire and makes the measurement by magnetic induction. This system will not work with d.c. With double parallel wire, such as a lamp or appliance line cord, the current flowing in the two wires cancels each other

out so a direct inductive reading is impossible. But a plug-in energizer accessory makes this measurement easy. The accessory plugs into the a.c. receptacle, the appliance plugs into the accessory, and the meter snaps into a hole in the device.

Current measurements like this are very helpful in figuring the actual line loads in your house. Very often you may want to power another appliance on a given receptacle and you're not sure if it's going to send fuses popping. A very effective way to prevent this is to measure the current draw for each item that's plugged into that particular branch circuit and add them up. You'll find that a refrigerator or freezer will draw about 12 amps. surge current when it first turns on. This immediately drops to about 2 to 2.5 amps. in normal running. This high surge won't blow fuses if you use a slow-blow-type fuse that withstands high momentary surge.

When you're shopping for a meter, there are special features and qualities you should be on the lookout for. More expensive instruments, for example, have meter-protecting circuits that prevent burnout on test voltages that are too high for the selected range. Even with this feature, when you measure an unknown voltage, it's always best to start with the highest range and work your way down one step at a time. Also check the number



PERIODIC BATTERY REPLACEMENT in a v.o.m. or v.t.v.m. is a must. Keep record of dates on the case

of measuring ranges. The less expensive v.o.m.s. may have only three resistance ranges, and this severely restricts possible accuracy. The same may be true of a.c. and d.c. voltage ranges, although most meters tend to have more ranges for these functions. The average v.t.v.m. will have six or seven ranges for resistance as well as a.c. and d.c. voltages, usually going up to 500 or 600 v. Some added flexibility is possible by using the meter with a high-voltage probe.

At the low end of the price scale for a v.o.m. is the \$5 to \$15 range represented, for example, by Allied's and Lafayette Radio's multitester lines. These tiny, self-contained v.o.m.s are battery-operated and are excellent for portable use—especially when checking out your automobile's electrical system and when you're working places where wall plugs aren't handy or conveniently located.

Bargains among larger, bench-sized v.o.m.s. are often found in kit form. Kit v.o.m.s. such as those from Knight-Kit (Allied Radio), the Heath Co. and EICO, run from \$20 to \$30. They're easy to build and generally can be assembled in one evening. The larger meter face provides much more accuracy than the pocket-size toolbox companion units and should be the choice if small size and compactness aren't too important.

One thing to look for in a meter if you plan to use one for checking electronic circuits is a high "input impedance." A meter shouldn't change the characteristics of the circuit being tested, and if the impedance is high a circuit under test can continue to operate without change. A typical v.o.m. has a very low impedance—10,000 or 20,000 ohms-per-volt. A 20,-

000 ohms-per-volt model, used to measure 10 v.d.c. for example, would create 10x20,000 or 200,000 ohms of input impedance—a figure that could drastically change the circuit's characteristics since the 200,000 ohms are placed directly in parallel with the entire circuit. The usual v.t.v.m., on the other hand, has 10 to 20 megohms (million ohms) impedance—which is high enough not to "load" the circuit.

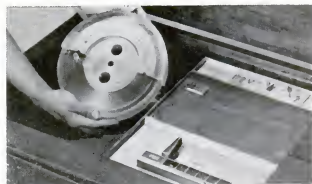
With its high-input impedance, the v.t.v.m. is perfect for electronic servicing, while still being useful for general household use. As input impedance goes up, however, so does price. RCA's Senior VoltOhmyst v.t.v.m., for example is over \$80. In kit form, however, the price is about \$60. A wide range of more moderately priced v.t.v.m.s is available in kit or wired form for those who do not need extremely high laboratory accuracy. Kit prices start at around \$30.

The latest class of meters to appear is the solid-state type. With their field-effect transistors (FETs) and integrated circuits (ICs), they, too, offer high-input impedance and accuracy plus the advantage of portability. They are available with and without current-measuring capacity. The solid-state jobs are generally a little more expensive. Still, prices start as low as \$20. ★ ★ ★

METER KIT is Heath's IM-17 solid-state, portable volt-ohmmeter. It's \$20, has 11 megohms d.c. input



Audio/Video Tape Recording



COLOR VIDEO TAPE CARTRIDGE is part of an engineering prototype of a home entertainment console. The CVR XXI (Color Video Recorder Twenty-First Century) incorporates a cartridge recorder, a playback unit and a color TV receiver. One hour of material can be recorded on the tape, which reverses to play or record on parallel tracks. Arvin Industries, Columbus, Ind.



SAPPHIRE PLAYTAPE I is one of Playtape's new Music Machines. It's a solid-state AM receiver and tape player designed for 1968 Volkswagens. The \$85 unit, made by Motorola, plays cartridges from the Playtape library. Playtape, 115 Broadway, New York.

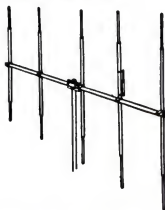


SOLID-STATE TAPE DECK is Harman-Kardon's entry into the tape deck field. Among the stereo TD-3's many features is a third tape head for erasing. Price of the deck is \$200. Harman-Kardon, Inc. Plainview, N.Y.



CASSETTE TAPE RECORDER features demonstration tape among accessories, which include remote-control mike, earphone, case. It's battery-powered; a.c. adapter optional. It's \$55. Channel Master Corp., Ellenville, N.Y.

Citizens Band Radio



DIRECTIONAL CB ANTENNA comes in kit form. The X-27-5 "beam" from Mosley is a 5-element unit with 9.5 db. forward gain. Kit is \$44; 3 and 4-element kits are also available from \$30. Mosley Electronics, 4610 N. Lindbergh Blvd., Bridgeton, Mo.



TINY CB CAR RADIO has 5-watt power on six channels. The 12-v. Amphenol 750, supplied with channel-9 crystals, measures $4\frac{3}{4} \times 2 \times 5\frac{1}{2}$ in. It's \$80. Amphenol Corp., 2875 S. 25th Ave., Broadview, Ill.

ELECTRONICS . . .

Radio/Television



AM/FM TABLE RADIO features electronic tuning to scan entire dial. Panasonic RE-6125, the Carmel, is \$70. Matsushita Electronic Corp. of America, 200 Park Ave., New York.



COLOR TV TUBE, checked with photocell and meter, exhibits great gain in brightness over previous designs. Color Bright 85 is in 1968 Sylvania sets. Sylvania Electric Products, Inc., 730 Third Ave., N.Y.

Hi-Fi Components and Systems



AUTOMATIC TURNTABLE is complete component: base and cartridge are part of Gardard Module SLx. The \$70 machine is ready to use. British Industries Corp., Westbury, N.Y.



FM TUNER KIT is an afternoon's project, since difficult and critical sections are prewired, pretested and prealigned. The Scott solid-state LT-112B-1 Broadcast Monitor Tuner incorporates field-effect transistor circuitry and integrated-circuit IF strip. The kit is \$200. H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass.



CONELESS LOUDSPEAKER is flat as a board in dimensions. But full-range sound is achieved with conventional electromagnetics driving plastic wafers. Model P20, 11 3/4 x 14 1/8 x 1 7/8 in., \$15. ERA Acoustics, 311 East Park St., Moonachie, N.J.

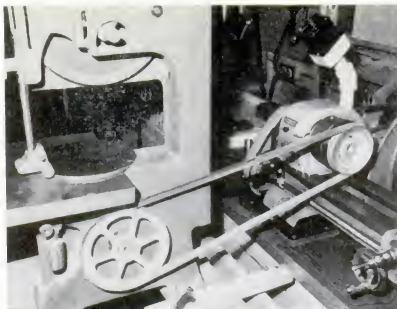
Electronic Systems



ELECTRONIC DESK is a complete communications center. The V.I.P. Electronic Desk, 74 in. wide and 36 in. deep, contains an electric clock, AM/FM radio, portable a.c./d.c. tape recorder, VHF/UHF television receiver, remote TV camera control for closed circuit TV, high-intensity lamp, and a.c. outlet. Price \$1300. Available from Interstate Industries, Inc. Merchandise Mart, Chicago, Ill.

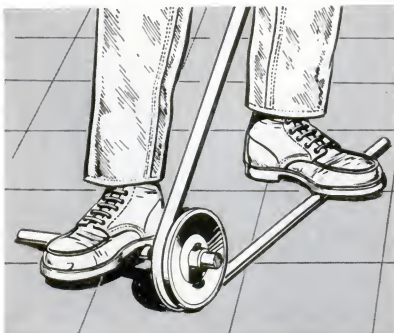
Cut metal with a band saw

All you need to handle metal-cutting jobs on your band saw is one of the special blades designed for metal work and some means of reducing the speed of the saw. One of the simplest ways to slow down the saw is to power it off a metal-cutting lathe, as shown at right. Simply clamp a small pulley in a three-jaw chuck to provide a belt connection at the lathe, and with the use of back gears, you have a choice of speeds to match the work. It's a simple setup that works.—*V. H. Siddens*



Bend tubing with a pulley jig

When you have to bend a length of soft tubing and a regular pipe bender isn't available, you can improvise an efficient bender using a V-belt pulley. Choose the pulley diameter that will give you the desired degree of bend. Then slide a rod through the shaft hole and use it to hold the pulley upright against the floor with your foot while you bend the tubing around it. Use a slow, steady pressure and you'll produce a smooth bend every time with no chance of kinking the tubing.—*Victor H. Lamoy*



NEXT MONTH IN SHOP AND CRAFTS

TRIPLE-SCREEN ROCK SORTER. All you rockhounds will want to check this unique construction project in the July issue. It's a 30-lb. specimen separator that disassembles into a compact package for true portability. Made from materials that are easily available, the rock sorter costs less than \$20. You'll find the plans in next month's *PM*.

KIT FOR A RADIO-CONTROL PLANE YOU CAN FLY. In just 12 to 15 hours, you can build—and fly—one of the new and exciting ARF (almost ready to fly) plane kits. Next month's subject will be a Sabre with a vacuum-formed fuselage, a molded Styrofoam wing and a remarkable resemblance to the F-86. Radio-control installation details will also help you to fly in a hurry.

HI-LO CAMPER SHELL FOR YOUR PICKUP. The July *PM* will include plans for an easy-to-build box cover that bolts over the bed of your truck and turns it into a snug shelter cabin. If you want more headroom, just slip in the high-rise sides.

BUILD YOURSELF A HOME SODA BAR. Closed, it looks like a hi-fi cabinet, but when the lid's open, you're all set to be your own soda jerk. Everything's handy to make refreshing, carbonated beverages for less than half what you pay at a store. And best of all, there are no bottles to return or cans to discard. It's in full color in our July issue.

Where do you find the answers to this summer's hottest question? Right under the question. Out of Schlitz? Look for the big sign. And pick up plenty of Schlitz from the multiple choice below.

A woman with dark hair, wearing a bright yellow short-sleeved shirt and a brown leather handbag, is smiling and holding three cans of Schlitz beer. She is standing in front of a large wall made of many Schlitz beer cans. A large red question mark sign is superimposed on the wall, with a Schlitz can inside it. Below the question mark is a circular sign that says "unthinkable". In the foreground, there is a sign that reads "Notice: The management is not responsible if you are out of Schlitz". At the bottom of the image, there is a large, stylized text that says "When you're out of Schlitz, you're out of beer". To the right of the text, there is a small shopping cart filled with Schlitz beer cans.

OUT OF SCHLITZ?

unthinkable

Notice:
The management
is not responsible if
you are out of Schlitz

*"When you're out of Schlitz,
you're out of beer"*

THE '69 CARS

(Continued from page 67)

haven't matched GM's concealed windshield wipers. Chrysler may have them on a couple of their bigger 1969 models, but Ford won't have them until 1970, as will the Chrysler intermediates. Wraparound bumpers, something the Thunderbird popularized several years ago, followed by Pontiac, are catching on throughout the industry. But vertical headlights—started by Pontiac in the early 1960s and then completely dropped this year—will be off the last of competitors' cars in 1969.

So much for a general summary of the 1969 cars. For a look at specific models, here's a company-by-company and division-by-division rundown:

GENERAL MOTORS

Chevrolet—The full-size Chevy will have bulging fenders, recalling some cars of yesteryear. The front end has a recessed plastic grille surrounded by the bumper. The grille peaks at the center, giving a V-shaped look. Taillights are still mounted in the bumper in clusters of three, but will be rectangularly shaped. Length is about one inch over the present 214. Sedans will have a new roofline.

The Camaro, like the big Chevy, will have new sheet metal and may be about four inches longer. Chevy IIs, Chevelles and Corvettes, new this year, will get some new trim and ornamentation. GM officials say there are still no plans to drop the Corvair and it apparently will be continued unchanged. There will also be a new three-speed automatic transmission for the small-engined cars.

Pontiac—The Grand Prix, formerly built on GM's full-size "B" body shell, will be based on a new design, called the "G" body. Basically, it's a GM "A" body modified for intermediate-size cars. The "A" body has a 112-inch wheelbase, but the new GP wheelbase has been stretched to 118 inches. The hood, about a foot longer than on intermediate-size cars, will be superlong, but with overall dimensions close to that of the present GP. The car will have a new snout featuring a V-shaped grille—a modification of the present battering-ram front end on Pontiacs.

The Pontiac Firebird, introduced as a mid-year model in 1967, will get its first major styling change in 1969. While the shell will be carried over, there will be new exterior sheet metal. It also may be slightly longer. The car may have rubber bumpers, the first car so equipped.

Pontiac will continue as an industry innovator. The company that first hid the windshield wipers is now going to hide

the radio antenna. Where? Some think in the windshield pillar, others in the roof. Not everything will be hidden, though. Headlights will be out in the open. Another innovation will be heating coils in the backlight, a neat way to defrost the rear window.

Oldsmobile—There will be new body shells for the "88" and "98" series. Olds will keep the split grille, but because of headlight placement, it will be closer in appearance to the Buick. The Toronado will get a new grille, taillamps and ornamentation. There's also unique side sculpturing on some of the Olds cars.

Buick—As elsewhere at GM, the new Buicks will eliminate side vent windows. The full-size cars will have a wraparound grille resembling that of the Riviera. Buick will make its own version of the new, low-cost three-speed automatic transmission for the Special series.

Cadillac—Cadillac will keep its traditional cross-hatch grille, but go back to horizontal headlights. The Eldorado will have only minor ornamentation changes.

FORD MOTOR CO.

Ford—The standard-sized Ford and the Mustang account for about 75 percent of the division's sales, and both will be all new in 1969—a big change by any standards. The wheelbase on the big Ford will be up two inches—going from 119 to 121. There will be more curvature to the side glass, and more tuck-under at the rocker panel to give a rounder, more streamlined appearance.

Ford will try to stay one step ahead of its station wagon competition by introducing a tailgate that can be opened like a door, but with the window up. On Ford's original two-way tailgate, the window had to be down to operate it.

The really big bang out of Ford next year will be the Mustang. It just may be the hottest production car this side of the Atlantic. Due is the Mach 1 Mustang—a car inspired by the Shelby limited production versions. It even looks the part—with simulated air scoops on the rear quarter panels, a rear-end spoiler and a functional air scoop on the hood. What's more, the duck tail, et al, are metal, not add-on plastic pieces as on the Shelby cars. The air scoop is so functional it's part of the engine—that is, it fits through a hole in the hood.

Under the hood of the Mach 1—a name Ford used for a recent dream car—is the 428-inch Cobra Jet engine. Other racing features include a pop-up gas cap and outside locking pins for the hood—plus a complete, high-performance package that

(Please turn to page 174)

You'll have to wait until you get there to rough it...



Chevrolet Suburban

3/4-ton Fleetside Custom Camper Pickup

Chevroleets have coil springs at all four wheels

You can have all the rugged going you want —after your Chevy camper pickup or Suburban gets you there. But on the way, settle back and enjoy the smooth ride.

Chevy's secret: deep coil springs at every wheel. Plus an Independent Front Suspension that blocks road bumps and jolts before they're passed on. It's enough to turn a corduroy road to velvet.

For power, you can count on Six and V8 engines ranging from 155 to 310 horsepower. With savings you can count on because every Chevy truck engine uses regular gas.

Choose your Chevy pickup, then order from a long list of special camper equipment from heavy-duty springs to auxiliary batteries. When you order a 9-passenger Suburban, you still get over 40 cu. ft. of cargo space behind the third seat.

We think things like mountains, woods and lakes ought to bring out the hardy soul in you —not the trip getting there. That's why Chevy recreational vehicles are so popular. And why you ought to see your Chevrolet dealer sometime soon. . . . Chevrolet Division of General Motors, Detroit, Michigan.



America's first choice truck every year since 1937

THE '69 CARS

(Continued from page 172)

includes a new limited-slip differential and shock-absorber system.

What next? In addition to a superperformance version, the Mustang will also have a new superluxury version with a fancy interior, geared to compete with the Cougar and Firebird.

The basic body is new, but keeps a strong resemblance to the present Mustang. The side scoops in the doors are gone, but the famous rectangular grille remains. However, the snout has a more thrusting look in that four inches have been added to the front end of the car. There are also two sets of headlights, the second within the grille, where the racing or parking lights used to be on some models. The car is a little roomier inside.

Where does all this leave Shelby? He's supposed to be working with Ford on a new two-seat sports car due out sometime in the 1969 calendar year.

Aside from the Cobra Jet engine, which first appeared as a Ford option this past spring, the company will have a new 351-cu.-in. V8 and a new 250-cu.-in. Six.

Lincoln-Mercury—The 1969 L-M models will mark the end of a three-year product development program designed to put the division in a position to compete model-for-model with the best of GM's offerings. The final phase will be the introduction of a new line of cars—the Marquis. Presently a model in the Mercury line, it's now being upgraded to compete with the Buick Electra and Olds 98. The Marquis resembles the Lincoln, but has disappearing headlights. It will have a restyled interior and full-width concave rear taillights.

At present, the full-size Mercury is built on a 123-inch wheelbase. That will be changed next year when the full-size cars will show up on both 121-inch and 124-inch wheelbases. The Mercury Marauder will be built on the 121-inch wheelbase—same as the new Ford. The Marquis, on a 124-inch wheelbase, will be four inches longer overall than the current Park Lane.

Intermediate-size Mercurys will get facelifts since they were all-new in '68. The Cyclone will get minor front and rear ornamentation changes. The Montego two-door hardtop will have a new roofline—one which is more formal appearing—similar to that of the new Ford Torino. The Montego line will add a Colony Park wagon with wood-grain side paneling. The Marauder looks like Mercury's answer to the Dodge Charger. It has the same "flying sail" extended roof-

line and simulated scoops in the rear quarter panels.

The Cougar will undergo major changes and add a convertible. The horizontally split grille is out, but there is still a V-shaped protrusion in the middle. Headlights are still concealed. Grille fins, however, are horizontal instead of vertical. A sculpture line on the side of the car resembles that on the Buick. The new Cougar will be three inches longer and two and one-half inches wider.

The Lincoln-Continental gets an "egg crate" grille with strong vertical definition. It's square-shaped in the center, like the new Continental Mark III. There's even more luxury touches than usual on the inside. The Mark III is unchanged.

CHRYSLER CORP.

Chrysler-Plymouth—The Plymouth Fury and all Chryslers will have an all-new body shell. However, the unitized floor structure and chassis are carried over from current models. Side windows will be even rounder than GM's in 1969.

Intermediate-size models will get only trim changes. But Chrysler, knowing a good thing when it sees it, will add a convertible to its popular Road Runner line.

The compact Valiant and sporty Barracuda will receive extensive trim changes.

The company, still trying to find a niche in the luxury market for the Imperial, will make another effort to match GM's successful approach to styling an expensive car. But Chrysler's going to save money, too, by shortening the wheelbase from 127 to 124 inches to match its other lines. It will drop Imperial's convertible.

Dodge—With the Chrysler "C" body being revamped for 1969, the Dodge Polara and Monaco models will also be changed. In the intermediate field, the Dodge Superbee—the division's answer to the Road Runner—will add a two-door hardtop and convertible model.

AMERICAN MOTORS

The Ambassador will undergo major front-end styling changes. Wheelbase and overall length will be increased four inches. Vertical headlights are replaced by horizontal lights on both Ambassador and Rebel. The Rebel looks different, too, but will not have all new sheet metal.

The Javelin and AMX will have only minimum ornamentation changes, as will the compact American line.

For the industry as a whole, the model change will cost about \$1 billion, meaning one thing is certain—you will have to pay more for the 1969 models. Prices will probably go up more than \$100, and warranties will be restricted. ★★★

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1000 EARS OF SOUNDPRINTS

(Continued from page 81)

average male speaking voice resonates at 120 cycles, the average female at about twice this frequency. The sound spectrograph records frequencies all the way from 50 to 7000 cycles.

The scanner is connected to a stylus assembly and a drum on which electrically sensitive paper is mounted. Changes in frequency appear on this paper as differences in the height of recorded lines. Time is indicated by distance on the horizontal. Volume shows up as shading—the louder the sound, the darker the area. Depicting loudness by shading this way produces a "bar" print. It is also possible to produce "contour" prints in which similar volumes are shown as wavy lines like similar altitudes on a topographic map.

Voiceprints are actually only one of many kinds of soundprints. Almost any sound can be depicted in the same way. The uses to which these pictures of sound can be put are almost endless. Ornithologists who have used soundprints to examine the songs of birds in detail have been amazed at what their ears had missed. A Swainson's thrush, for example, was found to sing six or eight separate songs every minute, seldom repeating any of them. The robin has a vocabulary of at least a dozen phrases, and the catbird clearly articulates more than a hundred.

The detail of sounds contained in soundprints—or spectrographs, as they're called technically—also permits deciphering garbled or damaged recordings. Clues to the causes of several aircraft crashes have been provided by meticulous soundprint analysis of pilots' last radio transmissions.

In surgery affecting the sounding chambers of the throat or head, such as a cleft palate operation, the progress of the patient can be checked by comparison of his soundprints. A tumor growing in this area may be detectable in the same way.

A tool for psychiatrists

A voice also betrays the emotional state of the speaker. Fear, happiness, anxiety are all reflected in the tone and speed of our voices. Some of the variations are so small, however, that even a trained psychiatrist's ear may miss them. The soundprint does not. It will detect the slight increase in frequency, the rising inflection at the end of a word, or the faster tempo of speech that signals a well-hidden anxiety in the speaker. Such clues may help a doctor to predict a violent change of personality in schizophrenic cases.

Perhaps the most dramatic use of the soundprint in medicine has been in the

diagnosis of heart difficulties. Before surgery can repair faulty heart valves, for instance, it must be determined just which valve is malfunctioning. At present, doctors measure pressure above and below these valves by catheterization—a complicated and painful procedure in which long tubes must be run through veins into the heart's chambers. By comparing soundprints of hearts suffering from known faulty conditions with those of the patient, it is easy to tell which valve is bad.

"We can see the day not too far distant," says Kersta, "when a heart condition can be diagnosed by telephone." In such a system, the sounds of the heart would simply be telephoned to the soundprint machine from the patient's home or a doctor's office.

Through breathprints, asthma and other allergy difficulties can be diagnosed without probing. Air whistling through constricted passages makes characteristic noises that show up on soundprints. Catalogs of such sounds, as well as others given off by body fluids, are now being assembled at several medical centers to be used as standards for comparison.

Spotting failures early

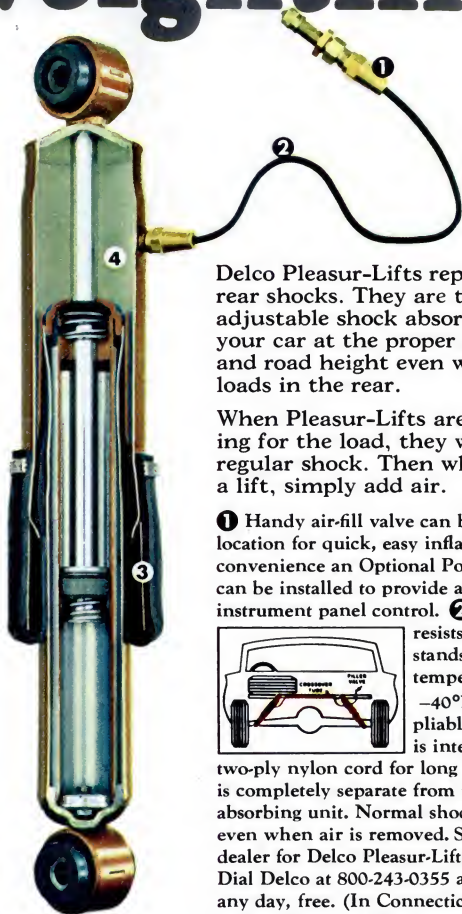
Soundprints are also finding important uses in industry. Aerojet General Corp., troubled with possible failure of missile shrouds during test firings, has turned to the soundprint for help. Transducers pick up high-frequency vibrations from the shrouds. By analysis of the resulting soundprints, weaknesses are detected before actual failure.

Similar soundprints can provide information on the interior condition of turbines, jets and even ordinary truck and auto engines. Out-of-balance shafts, improper cam action, failing gaskets—all these faults and more betray their presence by vibrations that the soundprint can detect.

One piano manufacturer uses soundprints to sort out good and bad hammers by the tone they make. How many more applications the soundprint may find is anyone's guess, but it is safe to say that anything that gives off a unique sound can be analyzed by this new science.

For more than a decade, research has been lavished on a device that would recognize a spoken word or command. The sound spectrograph, coupled to a computer, should be able to recognize not only a command but the particular voice speaking the words. Thus the voice-club may be just around the corner—its door opens only when a paid-up member recites the proper password! ★★★

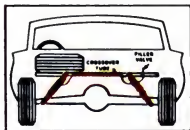
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YOUR FIRST MOTORCYCLE

(Continued from page 97)

engines rages today among cyclists like the "Ford man, Chevy man" dispute among car owners. As is customary in this type of argument, a lot more heat than light is generated, but there are a few facts buried in all the smoke and fury.

Generally speaking, two-cycles tend to use more gasoline and oil per mile than do four-cycles. Also, sparkplugs don't last as long. Two-cycles are more critical as to "tune" than four-cycles and are noisier.

Their advantages are basic simplicity and high-horsepower output from a lightweight engine. However, this high horsepower is obtained at the expense of being "peaky"—that is, optimum power is obtained through a rather narrow band of high rpm, and below this band, power tends to fall off abruptly. This is the reason motorcycles equipped with two-cycle engines have been going to five and six-speed transmissions, whereas the four-cycles stick to four-speed boxes.

The biggest two-cycle readily available is the 500-cc Suzuki 500/5. But Yamaha, Suzuki, Kawasaki, and Bridgestone in Japan, and Jawa in Czechoslovakia, all make 305 to 350-cc two-strokes.

Four-cycle middleweights include the 500-cc Velocette, Royal Enfield, Triumph T100R, 441-cc BSA Victor, the BMW 500-cc (exactly the same as the 600-cc except for piston displacement), and the Honda dual-overhead-cam 305-cc. From Italy comes the 350-cc single-cylinder, overhead-cam Ducati.

It is in the lightweight field—from 125 to 300 cc—that the two-cycle really begins to come into its own, however, with such sophisticated features as rotary intake valves, five-speed transmissions, tuned exhausts and oil injection systems (which make it unnecessary for you to mix oil with the gas).

The Japanese builders tend to build highly tuned, highly developed two-cycle machines. So do the makers of Spanish Ossas, Montesas and Bultacos. On the other hand, the Austrian Puch (distributed in the United States under the Allstate label by Sears), BSA Bantam and the Jawa are aimed more at those in the ride-to-work crowd who don't mind mixing their gas and oil and who value dependability over performance.

Even though two-cycles are increasingly popular in the lightweight class, there are many manufacturers who prefer to stay with their four-stroke designs. On the average four-cycle engines are more conventional, some being pretty much unchanged for years.

Besides BMW, lightweight four-cycle machines include the 160-cc Garelli, the 160 and 250-cc overhead-cam Ducati, the 250-cc Harley-Davidson (made by an Italian subsidiary), and the 250-cc Benelli (Wards sells certain Benellis under the Riverside label, by the way). From Britain comes the 250-cc BSA Starfire, and from Japan the 160, 175, 250-cc Hondas.

The bantamweights, machines that displace from around 80 to 125 cc, are great for getting around town and campus. The most economical to buy and operate, they get through dense, tangled urban traffic jams with the ease of a bicycle. They can be parked just about anywhere a bicycle can, and are so light they can be hoisted around for off-street parking.

Most of them are two-strokes, but Benelli, Moto-Guzzi and Honda make four-strokes in this range.

Still smaller motorcycles are available, most so severely underpowered they are little more than toys. Even in Japan, where economy is all-important, they are being eased off assembly lines due to lack of buyer interest.

So far most of the machines mentioned are intended for paved-street use. There is, however, an increasingly popular type called a "street scrambler," designed for the fellow who intends to do most of his riding in the street, but who likes now and then to get off in the dirt and climb hills, crash through brush or cross creeks. Basically, these are street machines with street suspension and full legal equipment—lights, an effective muffler, a license-plate holder, and so on—but with exhaust pipe (or pipes) tucked high up out of the way. Often they have slightly lower gearing for additional pulling power and come equipped with "knobby" tires for better traction in the dirt. In their purest form—minus legal street equipment—such machines are often called "trail" bikes. Some makers, however, refer to their street scramblers as trail bikes.

There are two motorcycles that approach this street/off-road problem from the opposite direction. The Italian Moto-Beta is a 100-cc two-cycle specifically designed for American dirt competition events, scrambles, enduros, cross-country runs and the like. It can give a good account of itself just as it comes off the dealer's floor, but for street use can be fitted with the legally required equipment.

A similar machine is the 90-cc Hodaka, built in Japan to the specifications of its American distributor and available only in the United States. Like the Model "T" Ford, it comes in one color, one model. It's a true dual-purpose machine because

(Please turn to page 182)

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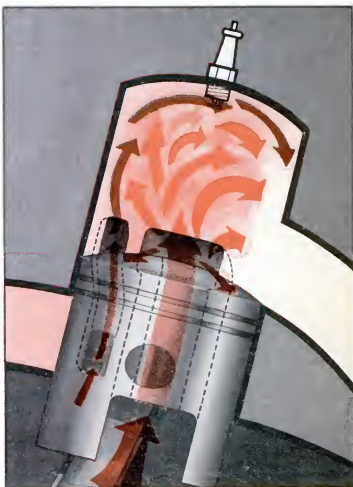
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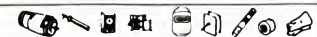
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YOUR FIRST MOTORCYCLE

(Continued from page 180)

—although it comes with full street equipment—its suspension, frame geometry, and so on are specifically designed for going in the rough. There are probably more accessories and options available for the Hodaka than any other motorcycle on the American market.

Some authorities claim the 100-cc street scrambler is the ideal bike for the beginning rider. It's cheap, tough, generally untemperamental, and its fairly high ground clearance allows it to be ridden over fields and on trails out of the way of traffic. Once you learn to ride and handle your mount in the rough, you'll find pavement riding a cinch.

There are many advantages to buying a new machine. For one, just about any motorcycle available on the American market can be delivered immediately if you buy new. You get a warranty that may cover as much as 25,000 miles (e.g., Benelli). You know the condition of your machine and the care it has received, whereas with a used machine you may have doubts about its reliability. And, of course, there is always some risk that the used cycle may be just about worn out, although with the modern motorcycle this is pretty much a rare occurrence.

The buyer of a new bike has the definite advantage of being able to specify the exact equipment he wants. Such things as choice of handlebars, gas tank, sprocket ratios, tires, seat and foot pegs may make the difference between a machine that is a pleasure to ride and own, and one that is thoroughly unlovable.

The outstanding advantage of buying a used bike is the cost factor. Motorcycles, like everything else, are cheaper second-hand. A remarkably large number of cycles are offered for sale by the original buyers before they have run a thousand miles. In almost every case, they are good buys if they aren't beat up, don't leak oil and run properly. There can be a 30 to 40-percent (or greater) saving over the price of these same bikes new.

Many older machines are in surprisingly good shape, but unless the individual cycle is known to the buyer, it can be like buying a pig in a poke. The general appearance of a used motorcycle is important. If it's scroungy-looking on the outside, likely enough things are in the same shape inside. The best bet with a used bike is to buy from a dealer willing to give a definite guarantee. In any event, bear in mind that as a rule of thumb, parts for Japanese motorcycles are cheapest. Good riding! ★★

SHATTERPROOF CUTOFF WHEEL

(Continued from page 155)

at the rim, new particles are constantly exposed, making the wheel self-sharpening. We deliberately wore a disc down from its original 7-in. diameter to about 2 in. and it was cutting just as well at the end as at the beginning.

The disc is actually two tools in one. Used edgewise, it's a cutting wheel. Used on its side, it becomes a grinding wheel. It will smooth, shape, sharpen and sand a variety of materials from wood to tough iron castings. It can also be used to strip off old paint and other finishes. The open mesh construction prevents the disc from clogging and keeps the abrasive particles cutting cleanly.

A rubber backup pad—the kind used with a conventional sanding disc—can be mounted behind the wheel to give it added stiffness when you want to press against its face. For cutting, the pad is removed. Only about $\frac{1}{16}$ in. thick, the disc makes a very fine cut—much narrower than a conventional cutoff wheel. This is handy for making precision cuts, such as in notching a tile to go around a pipe or mitering a piece of angle iron for a corner bend. The disc also smooths as it cuts, so that further finishing is seldom needed.

Using the wheel does require a certain knack. You must let it do its own cutting—you can't force it. Pressing too hard just wears the rim without speeding up the cut.

Good speed is important, too. The disc performed best in a drill turning at 2200 rpm and did moderately well in a 1200-rpm model. It performed least satisfactorily in drills of 500 to 800 rpm.

The disc's thinness calls for care when you're following a line. If the wheel starts to wander off, you can't horse it back by brute force. This just twists the disc and may cause it to jam. The trick here is to back off, grind away the material *side-ways* until you're back on the line, then go forward again.

The disc is not a substitute for the heavier type of rigid cutoff wheel on jobs that are best done with a portable circular saw. Its main charm is as a handy, all purpose, cut-anything shop accessory that you can chuck in a drill at a moment's notice for a variety of chores. One important caution: Because the wheel throws quite a shower of chips and dust, protective goggles are a must.

The new wheel will be called the Zip-pidi-Do. It will be sold in a kit including a rubber backup pad and a $\frac{1}{4}$ -in.-shank arbor. Price will be \$4 from Coastal Abrasive and Tool Co., P.O. Box 337, Trumbull, Conn. 06611. ★ ★ ★

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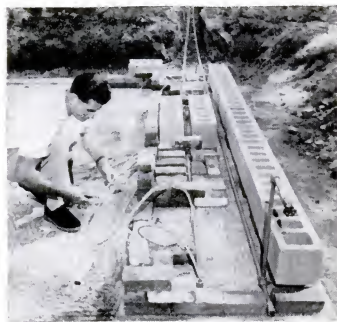
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BUILD THIS COOKOUT BAR

(Continued from page 136)



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COOKOUT BAR IS BUILT UP of blocks and faced with brick after water and electric lines are in place

with water and tamping it to 8 in. This was followed by installing form boards, adding reinforcing wire, pouring the concrete, striking it off level, scratching the surface with a rake and finally covering it with building paper for curing. Scratching the surface is done only if the patio is to be tiled, otherwise you simply trowel the concrete smooth when it begins to set. It will take a week for the concrete to cure properly during which time it should be kept moist with a hose.

You will notice in the photo showing the form boards that separate forms are provided so the footings for the wall and cookout bar can be poured separately

(Please turn to page 186)

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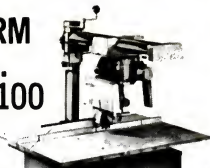
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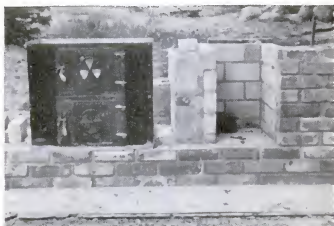
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BUILD THIS COOKOUT BAR

(Continued from page 184)



COMPLETED WALL, faced with brick, is finally capped with a poured-in-place concrete coping 2 in. thick



METAL GRILL establishes height of poured counters. Partially completed open firepit is shown alongside

from the patio. The footings are actually poured first, then the forms are pulled out and strips of expansion felt are placed against the concrete before the patio is poured. Wiring for the lamp posts and piping for the water should be in place before any concrete is poured.

I built the cookout bar around two metal grills, one made by the Majestic Co., and the other by Donley Brothers, and used concrete block to lay up a rough structure. Then I faced the block with used bricks bought for a penny each.

Forms for the poured-slab counters are partially supported by two wooden cabinets which provide on-the-spot storage for pots and pans and charcoal. Note that I covered the chimney top with a slab, too, leaving an opening in the brick at the front for the smoke. I later gave the counters and the coping along the top of the wall a coat of latex paint. The pit for the twin-fire grill holds two charcoal baskets which hang on each side to char-broil steaks hung between them. The pit measures 12½ in. wide, 20 in. deep and 32 in. high. The main grill is a complete unit—your simply brick around it. ★★



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(Continued from page 101)

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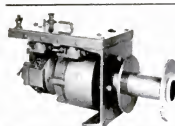
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SUPERSECRET SPY PLANE

(Continued from page 62)

flamed out over Russia. What's the SR-71 really doing? Again, only God and the Pentagon know, with the usual results.

One thing is known. The pilots, even for routine flights, are treated like astronauts. They get preflight physicals, are put on a high protein diet—then suited up in special flight gear by specialists who stay with them until they are plugged into the Blackbird's system.

The rest is conjecture. Nobody knows where they go, but with a 2000-mph speed and a 2000-mile-plus range, they could get there and back in two hours. Do all the flights take off from Beale? Well...

Physically, the SR-71 is slightly taller and about six feet longer than the YF-12, and its flanged nose section resembles a sting ray. But to the average eye, the two planes look identical. Internally, of course, the SR-71 substitutes reconnaissance equipment for armament.

The SR-71 is also reported to have probably the most accurate (better than one nautical mile per hour) inertial navigation system in any aircraft. Similar to those used in missiles, it is mounted on gimbals and takes periodic sightings of stars which are then fed to a computer to determine corrections. The plane can then fly, hands off, and in complete silence (no radio contact) with complete precision.

Pretty sneaky.

About the black paint. Early tests showed that, like the X-15, the plane is so fast, the skin temperatures built up so high they endangered the electronic gear. Even the Air Force decals burned off. Black helps keep the temperature down.

Even so, special lubricants were necessary in the nose. The normal lubricants melted and ran out. Leading edge temperatures reached 1000° F.

The YF-12/SR-71 story is one of the best mystery stories of recent years. Why is one not allowed to do what it could do and what is the other really doing? The mystery might never be solved. ★★

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ONE-MAN SPORTS SUBMARINE

(Continued from page 90)

down, with the water level just reaching it. I raised it to the 45° position, and the water, gurgling all the while, rose to meet it again. I was still just barely on the surface. Now I raised it to the horizontal position. The water level came up again, and the sub, with me sitting in it, began to sink.

Down, down we went, until finally—*clunk*—we were resting at a slight angle, amidst the clean weeds nearly two feet high, on the floor of the Springs. Despite the angle, the craft seemed in no danger of tipping all the way over.

Even so, since my middle name is Chicken Delight, I pushed the pipe-valve back to the vertical position quickly, opened the compressed-air valve and we "hissed" our way back to the surface.

What had happened, and what took Markham several years to figure out, was that the volume of the trapped air inside the chamber was adjustable—allowing the craft to sink or rise, or remain where it was, depending on the volume of air. And the ballast at the bottom of the craft, including the batteries and my own weight, kept the air balanced almost at top center of the submarine, preventing tipping.

Trapping the air is easy. Just push an empty glass, top down, into a basin of water. If the glass is pushed down evenly, no water rises past the rim. What Markham has done with the buoyancy valve is raise the "rim" of the sub's chamber to the rim of the valve. As the valve is raised, water enters the chamber until it again reaches the valve. As the water rises, the volume of air becomes less, and the craft sinks. If the valve is lowered, and more compressed air is forced into the chamber, the water level recedes. As it recedes, the air volume increases, the craft becomes more buoyant, and it rises.

The ballast is the second important factor. The trapped air is worthless if the craft does not have enough weight to pull it down appreciably, over and above the volume of air, and—most important—if the craft is so unstable it would tip partially or all the way to let the air escape.

Markham solved the ballast problem by centering all the weight almost directly beneath the trapped air. Three storage batteries, the diver's own weight, plus two lengths of ordinary railroad rails slid in on the ballast tray alongside the battery case keep it balanced, with, Markham claims, a maximum tilt of 15°.

"Even if you force it," he says, "it acts like a pendulum and wants to return to the upright position."

The rails can be one, two or three-foot lengths, so a lightweight wife or daughter can ride as well as Big Daddy, making up the difference of body size. Or the rails can be slid forward or back for variations in balance.

All of this, remember, is without power. The craft will go up and down, like an elevator, with just the valve adjustments, but without much other control. With power, however, the valve can be set at neutral buoyancy—about a 45° angle—and the motors and control surfaces will take it up, down, forward, left or right.

After I'd returned to the surface, I set the valve at 45°, turned on the motors (powered by the batteries I was sitting on), and toiled around the Springs for about 15 minutes.

This is what other builders will miss. Silver Springs, through their glass-bottom boats, is pretty enough, but driving around in it underwater is pure joy.

The sub is not a speedster. Its two motors—ordinary trolling motors—develop, at best, ¾ hp each. But it's meant for pleasure, so what's the hurry?

It has two controls, operated from a steering wheel. Turn the wheel left or right—the craft's two rudders turn left or right. Pull the wheel back or push it forward—the motors tilt up or down.

I could fault the sub here. I'm an airplane pilot, and pulling the wheel back to go down, and pushing it forward to go up is awkward. Markham says it could be reversed by lowering the wheel and rerigging the connections. There isn't enough room in the nose housing now.

A second problem is the fogging, which Markham hasn't solved, although I suspect a small electric fan might help forward visibility through the dome. I had to swab it off with a rag occasionally.

A price list goes like this:

Plywood	\$30
Fiberglass cloth	20
Plexiglas canopy	50
Railroad rails	10
Motors	80
Storage batteries	50
Miscellaneous fittings	15

So \$250 is a good mean average. Markham has a source for the canopies, although he says any local plastics shop can blow one. Other material is stock.

The batteries—ordinary auto batteries—are kept dry by trapping air the same way the dome traps air at the top. Their casing is relatively close-fitting, and only when you go into deep water will any water seep in around the bottom.

The compressed-air tank fits neatly into the nose compartment, or can be worn on the back if the diver intends to park on the bottom and go scuba diving. ★★ ★

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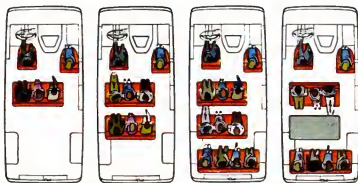
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